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Technical Description of MOBILE6.2 and Guidance on Its Use for Emission Inventory Preparation

DRAFT REPORT

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Acronyms

ETBE =	Ethyl tertiary butyl ether
ETOH =	Ethanol
FTP =	Federal Test Procedure
HAP =	Hazardous Air Pollutant
MOBTOX =	EPA's first highway vehicle toxic emission factor model, used in a 1993 study
MOBTOX5b =	EPA's revised highway vehicle toxic emission factor model, used in several EPA assessments, beginning in 1999
MOBILE =	EPA's emission factor model for HC, CO, and NO_x. PM and toxics are being added to the most recent version, MOBILE6
MTBE =	Methyl tertiary butyl ether
NSATA =	National-Scale Air Toxics Assessment
TAME =	Tertiary amine methyl ether
TOG =	Total organic gases
UC =	Unified Cycle

1.0 Background

This document describes the methodology used to estimate air toxic emission rates in the toxics module for MOBILE6 (MOBILE6.2), describes the sources of data used, and provides users with guidance on how to obtain data required as input parameters for the model. The document also compares some MOBILE6.2 results to results using a previous highway mobile source toxics emission factor model, MOBTOX5b.

EPA has developed two previous toxic emission factor models for highway mobile sources. These models were developed primarily for internal assessment purposes and neither were officially released. However, both were released in draft form for use outside of EPA. The first model, MOBTOX, was developed as part of an assessment of toxic emissions, exposure, and risk, released in 1993 as the Motor Vehicle-Related Air Toxics Study.[1] This model applied toxic fractions on a technology group basis to total organic gas (TOG) gram per mile emission factors to calculate air toxic emission factors. The TOG emission factors were derived from a version of MOBILE4.1 modified to account for control programs mandated by the Clean Air Act Amendments of 1990. Using MOBTOX, average nationwide in-use toxic emission factors could be estimated for benzene, 1,3-butadiene, formaldehyde, and acetaldehyde, for a number of evaluation years and possible control scenarios.

Several years later, EPA developed a new toxic emission factor model, MOBTOX5b.[2, 3, 4] The model was used in several EPA assessments, including the Regulatory Impact Analysis for the Tier 2/Gasoline Sulfur Final Rule,[5] the Regulatory Impact Analysis for the 2007 Diesel-Sulfur Rule, [6] the Technical Support Document for the Mobile Source Air Toxics Rule,[7] and the 1996 National Toxics Inventory and National Scale Air Toxics Assessment.[8, 9] MOBTOX5b includes MOBILE6 model enhancements and represents a substantial improvement over the preliminary version used in the 1993 study. The model has the capability to account for differences in exhaust toxic fractions of TOG between normal and high emitting vehicles in calculating emission rates. Moreover, the model accounts for the impacts of aggressive driving and air conditioning usage on toxics. The impacts of fuel reformulation programs and changes in vehicle emission control technology can also be addressed with the model. The model accounts for the impacts of specific fuel parameters included in the Complex Model for reformulated gasoline and a draft fuel effects model for MTBE.[10, 11] Finally, whereas separate runs had to be done for each toxic with the first version of MOBTOX, MOBTOX5b allows the user to model benzene, formaldehyde, acetaldehyde, 1,3-butadiene, and MTBE in one run. Unfortunately, the input structure of MOBTOX5b is quite complicated and the model is difficult to use. This is because the model consists of several separate software tools that are not fully integrated into the MOBILE framework.

Combining the air toxic and MOBILE models is a recommendation of the National Academy of Science Research Council's review of MOBILE.[12] MOBILE6.2 fulfills this need, simplifies the modeling process, and provides a single, consistent interface for modeling vehicle pollutants. The MOBILE6 toxics module fully integrates the calculation of highway vehicle air

toxic emission factors for benzene, 1,3-butadiene, formaldehyde, acetaldehyde, acrolein, and MTBE into the modeling framework. It also integrates toxic emissions data and algorithms from EPA's Complex Model for Reformulated Gasoline. Moreover, the model can estimate emissions of other hazardous air pollutants (HAPs) based on user provided information.

2.0 Calculation of Toxic Emission Rates

MOBILE6.2 explicitly estimates emissions for the following compounds:

1) Benzene – A known human carcinogen that causes leukemia and other blood disorders

2) 1,3-Butadiene – Causes excess incidence of leukemia in humans, and also a variety of reproductive and developmental effects in mice and rats

3) Formaldehyde – A likely human carcinogen that causes nasal tumors in rats, and is a respiratory irritant

4) Acetaldehyde – A likely human carcinogen that causes nasal tumors in rats, and is a respiratory irritant

5) Acrolein – A respiratory tract irritant

6) MTBE – Causes kidney lesions, swelling around the eyes and increased prostration in rats. It is also associated with tumors of kidneys and testes in male rats and liver tumors in female mice

The above compounds, except for MTBE, dominate risk from mobile sources, based on results of the recent National-Scale Air Toxics Assessment.[8] Benzene and MTBE are found in both exhaust and evaporative emissions; the others are constituents of exhaust only. Emission factors are reported according to whether they are exhaust, crankcase, diurnal, hot soak, running loss, resting loss or refueling loss emissions. MOBILE6.2 also distinguishes between exhaust start and running emissions. Emissions are reported by vehicle class for the 28 vehicle types included in MOBILE6 (Table 2.1). MOBILE6.2 also has a command (AIR TOXICS EF) which allows the user to enter emission factors or air toxic to TOG ratios for additional air toxic pollutants. This command is described in more detail in Section 2.4.

2.1 Exhaust Emissions for Benzene, 1,3-Butadiene, Formaldehyde, Acetaldehyde, and MTBE

The exhaust component of the toxics module multiplies the toxic ratio by the MOBILE6.0 TOG (or volatile organic compound, VOC, for some technology groups) estimates to produce an air toxic emission estimate in MOBILE6.2. For light-duty gasoline vehicles, the product is then multiplied by an off-cycle adjustment factor, explained in more detail below,

Table 2.1. MOBILE6 Vehicle Classifications

Number	*Abbreviation*	*Description*
1	LDGV	Light-Duty Gasoline Vehicles (Passenger Cars)
2	LDGT1	Light-Duty Gasoline Trucks 1 (0-6,000 lbs. GVWR, 0-3,750 lbs. LVW)
3	LDGT2	Light-Duty Gasoline Trucks 2 (0-6,001 lbs. GVWR, 3,751-5750 lbs. LVW)
4	LDGT3	Light-Duty Gasoline Trucks 3 (6,001-8500 lbs. GVWR, 0-5750 lbs. ALVW)
5	LDGT4	Light-Duty Gasoline Trucks 4 (6,001-8500 lbs. GVWR, 5,751 lbs. and greater A LVW)
6	HDGV2b	Class 2b Heavy-Duty Gasoline Vehicles (8501-10,000 lbs. GVWR)
7	HDGV3	Class 3 Heavy-Duty Gasoline Vehicles (10,001-14,000 lbs. GVWR)
8	HDGV4	Class 4 Heavy-Duty Gasoline Vehicles (14,001-16,000 lbs. GVWR)
9	HDGV5	Class 5 Heavy-Duty Gasoline Vehicles (16,001-19,500 lbs. GVWR)
10	HDGV6	Class 6 Heavy-Duty Gasoline Vehicles (19,501-26,000 lbs. GVWR)
11	HDGV7	Class 7 Heavy-Duty Gasoline Vehicles (26,001-33,000 lbs. GVWR)
12	HDGV8a	Class 8a Heavy-Duty Gasoline Vehicles (33,001-60,000 lbs. GVWR)
13	HDGV8b	Class 8b Heavy-Duty Gasoline Vehicles (>60,000 lbs. GVWR)
14	LDDV	Light-Duty Diesel Vehicles (Passenger Cars)
15	LDDT12	Light-Duty Diesel Trucks 1and 2 (0-6,000 lbs. GVWR)
16	HDDV2b	Class 2b Heavy-Duty Diesel Vehicles (8501-10,000 lbs. GVWR)
17	HDDV3	Class 3 Heavy-Duty Diesel Vehicles (10,001-14,000 lbs. GVWR)
18	HDDV4	Class 4 Heavy-Duty Diesel Vehicles (14,001-16,000 lbs. GVWR)
19	HDDV5	Class 5 Heavy-Duty Diesel Vehicles (16,001-19,500 lbs. GVWR)
20	HDDV6	Class 6 Heavy-Duty Diesel Vehicles (19,501-26,000 lbs. GVWR)
21	HDDV7	Class 7 Heavy-Duty Diesel Vehicles (26,001-33,000 lbs. GVWR)
22	HDDV8a	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)
23	HDDV8b	Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs. GVWR)
24	MC	Motorcycles (Gasoline)
25	HDGB	Gasoline Buses (School, Transit and Urban)
26	HDDBT	Diesel Transit and Urban Buses
27	HDDBS	Diesel School Buses
28	LDDT34	Light-Duty Diesel Trucks 3 and 4 (6,001-8,500 lbs. GVWR)

which accounts for the difference in toxic fractions between Federal Test Procedure (FTP) and Unified Cycle (UC) operation. Mathematically, it is represented by:

Ratio = g/mi Toxic from Air Toxic Module / g/mi TOG from Air Toxic Module **(1)**

Final Toxic Emission Factor = Ratio * TOG emissions from MOBILE6*$ADJ_{TOX\ UC/FTP}$ **(2)**

Toxic to TOG ratios vary by technology group, vehicle type, whether a vehicle is a normal or high emitter (same definition as MOBILE6), and fuel characteristics. Ratios for individual technology group/vehicle type/emitter class combinations are determined using a series of algorithms which calculate the ratios based on fuel parameter inputs. Since toxic emission rates are a product of toxic to TOG ratios and TOG emission rates, anything that reduces TOG will also result in toxic emission reductions.

Benzene, 1,3-butadiene, formaldehyde, and acetaldehyde exhaust emissions from light-duty gasoline vehicles with three-way or three-way plus oxidation catalysts were estimated using

algorithms developed for the Complex Model for Reformulated Gasoline. For MTBE, a draft fuel effects model based on the Complex Model database was used.[11] These algorithms were also used in MOBTOX5b. It should be noted that the sulfur effects terms in the algorithms were not used; instead, sulfur impacts on toxic emissions were assumed to be proportional to the sulfur impacts on total VOC estimated by MOBILE6. The Complex Model algorithms are based on data from vehicles representing a 1990 model year fleet. Toxic to TOG ratios for advanced technology vehicles running on a given fuel, such as California low emission (LEV) and Tier 2 vehicles, could be different than ratios based on the fleet in the Complex Model database. However, test data are far too limited to develop algorithms for advanced technology vehicles. Toxic emissions data from a small number of California Low Emission Vehicles[13] suggest toxic to TOG ratios from vehicles are similar to those of vehicles in the Complex Model database, but additional testing and analysis are needed.

For benzene, 1,3-butadiene, formaldehyde, and acetaldehyde, the algorithms are based on about 1800 observations; for MTBE they are based on a nearly 900 observations. These algorithms are applied by stratifying the light-duty gasoline fleet into ten Technology Groups and applying the algorithms individually to each group (this is known as the unconsolidated Complex Model). The ten groups are formed as a combination of fuel system, catalyst type, Air injection (y/n toggle), EGR, and Normal / High emitter status. These groups are listed in Table 2.2. The first nine groups represent only normal emitting vehicles (same definition as MOBILE6). The tenth group represents all of the high emitters, regardless of technology.

Table 2.2. Technology Groups in the Complex Model for Reformulated Gasoline

Technology Group Definitions				
Technology Group	**Fuel System**	**Catalyst**	**Air Injection**	**EGR**
1	PFI	3WAY	NO AIR	EGR
2	PFI	3WAY	NO AIR	NO EGR
3	TBI	3WAY	NO AIR	EGR
4	PFI	3WAY + OX	AIR	EGR
5	PFI	3WAY	AIR	EGR
6	TBI	3WAY	AIR	EGR
7	TBI	3WAY + OX	AIR	EGR
8	TBI	3WAY	NO AIR	NO EGR
9	CARB	3WAY + OX	AIR	EGR
High Emitters	ALL	ALL	ALL	ALL

PFI = port fuel Injection, TBI = throttle body injection, CARB = carburetor, 3WAY = three way catalyst, 3WAY + OX = three way plus oxidation catalyst, ERG = exhaust gas recirculation

The Complex Model algorithms can be found in the regulatory impact analysis for the 1993 Reformulated Gasoline Rule.[10] Separate toxic ratios are calculated for each of the groups and weighted together by the fraction of the fleet attributable to each technology group in MOBILE6. These fractions can be obtained from the MOBILE6 TGS array.[14]

For light-duty gasoline vehicles with oxidation catalysts only or no catalysts, toxic to VOC ratios are determined using algorithms derived from a more limited data set from about 50 vehicles tested on a baseline fuel and a small number tested on reformulated fuels. Data were not available to develop algorithms for ETBE and TAME blends; thus, the algorithms for ethanol oxygenated gasoline were used for ETBE blends, and the algorithms for MTBE oxygenated gasoline were used for MTBE blends. Algorithms for light-duty diesel vehicles and heavy-duty engines are based on only a few tests. These algorithms for diesel vehicles and engines do not include any impacts of fuel parameters. Although diesel fuel parameters, such as cetane, do seem to have an impact on toxics emissions, data are inadequate to quantify them.[15] No speciation data were available for highway motorcycles; thus, algorithms for non-catalyst light-duty vehicles were used, since most motorcycles in the fleet do not have catalytic converters. The algorithms for older technology light-duty gasoline, light-duty diesel, and heavy-duty vehicles were also used in MOBTOX5b and are provided in Table 2.3. The specific studies which comprise the data set for these algorithms are described in Appendix D of the 1999 document, "Analysis of the Impacts of Control Programs on Motor Vehicle Toxics Emissions and Exposure in Urban Areas and Nationwide."[3]

For light-duty gasoline vehicles, toxic to TOG ratios developed using the algorithms described above were also adjusted to account for the impacts of aggressive driving. These adjustments were applied to start and running emissions, as well as all speeds and roadway types. Adjustments to account for aggressive driving were based on analysis of data from vehicles running on both the Federal Test Procedure (FTP) Cycle, which does not account for aggressive driving, and the Unified Cycle (UC), which does. The adjustment is applied as shown previously in equation 2. These adjustments were developed for MOBTOX5b, and are given in Table 2.4. The adjustments are based on an analysis of UC and FTP emissions data from 12 vehicles collected by the California Air Resources Board. Details of the analysis of these data can be found in Appendix G of the 1999 document, "Analysis of the Impacts of Control Programs on Motor Vehicle Toxics Emissions and Exposure in Urban Areas and Nationwide."[3] There are separate adjustments for normal and high emitters.

Table 2.3 Exhaust Toxic Fraction Equations for LDGV with Oxidation Catalysts, Non-Catalyst LDGV, HDGV, LDDV and HDDV

Vehicle Class/ Catalyst	Baseline Gasoline	MTBE Gasoline	EtOH Gasoline
Benzene			
LDGV and LDGT/oxcat	Bz/TOG = (0.8551* (vol. % Bz) + 0.12198 * (vol. % Arom.) - 1.1626)/100	Bz/TOG = (0.8551* (vol. % Bz) + 0.12198 * (vol. % Arom.) - 1.1626)/100	Bz/TOG = (0.8551* (vol. % Bz) + 0.12198 * (vol. % Arom.) - 1.1626)/100
LDGV and LDGT/noncat MC	Bz/TOG = (0.8551* (vol. % Bz) + 0.12198 * (vol. % Arom.) - 1.1626)/100	Bz/TOG = (0.8551* (vol. % Bz) + 0.12198 * (vol. % Arom.) - 1.1626)/100	Bz/TOG = (0.8551* (vol. % Bz) + 0.12198 * (vol. % Arom.) - 1.1626)/100
HDGV/noncat	Bz/TOG = (0.8551* (vol. % Bz) + 0.12198 * (vol. % Arom.) - 1.1626)/100	Bz/TOG = (0.8551* (vol. % Bz) + 0.12198 * (vol. % Arom.) - 1.1626)/100	Bz/TOG = (0.8551* (vol. % Bz) + 0.12198 * (vol. % Arom.) - 1.1626)/100
HDGV/cat	Bz/TOG = (1.077 + 0.7732*(volume % benzene) + 0.0987 * (volume % aromatics - volume % benzene))/100	Bz/TOG = (1.077 + 0.7732*(volume % benzene) + 0.0987 * (volume % aromatics - volume % benzene))/100	Bz/TOG = (1.077 + 0.7732*(volume % benzene) + 0.0987 * (volume % aromatics - volume % benzene))/100
LDDV	Bz/TOG = 0.0200		

Vehicle Class/ Catalyst	Baseline Gasoline	MTBE Gasoline	EtOH Gasoline
LDDT	Bz/TOG = 0.0200		
HDDV	Bz/TOG = 0.0105		
Formaldehyde			
LDGV and LDGT/oxcat HDGV/cat	Form/TOG = 0.0151	Form/TOG = 0.0151 + ((0.0151 * 1.2082)*(wt % MTBE/2.7))	Form/TOG = 0.0151 + ((0.0151 * 0.3350)*(wt % EtOH/3.5))
LDGV and LDGT/noncat MC	Form/TOG = 0.0224	Form/TOG = 0.0224 + ((0.0224 * 0.4336)*(wt % MTBE/2.7))	Form/TOG = 0.0224 + ((0.0224 * 0.1034)*(wt % EtOH/3.5))
HDGV/noncat	Form/TOG = 0.0347	Form/TOG = 0.0347 + ((0.0347 * 0.1259)*(wt % MTBE/2.7))	Form/TOG = 0.0347 + ((0.0347 * 0.1034)*(wt % EtOH/3.5))
LDDV	Form/TOG = 0.0386		
LDDT	Form/TOG = 0.0386		
HDDV	Form/TOG = 0.0782		

Vehicle Class/ Catalyst	Baseline Gasoline	MTBE Gasoline	EtOH Gasoline
Acetaldehyde			
LDGV and LDGT/oxcat HDGV/cat	Acet/TOG = 0.0047	Acet/TOG = 0.0047 + ((0.0047 * 0.2556)*(wt % MTBE/2.7))	Acet/TOG = 0.0047 + ((0.0047 * 2.1074)*(wt % EtOH/3.5))
LDGV and LDGT/noncat MC	Acet/TOG = 0.0060	Acet/TOG = 0.0060 + ((0.0060 * 0.2303)*(wt % MTBE/2.7))	Acet/TOG = 0.0060 + ((0.0060 * 1.1445)*(wt % EtOH/3.5))
HDGV/noncat	Acet/TOG = 0.0067	Acet/TOG = 0.0067	Acet/TOG = 0.0067 + ((0.0067 * 1.1445)*(wt % EtOH/3.5))
LDDV	Acet/TOG = 0.0123		
LDDT	Acet/TOG = 0.0123		
HDDV	Acet/TOG = 0.0288		

Vehicle Class/ Catalyst	Baseline Gasoline	MTBE Gasoline	EtOH Gasoline
1,3-Butadiene			
LDGV and LDGT/oxcat	Buta/TOG = 0.0044	Buta/TOG = 0.0044 + ((0.0044 * -0.2227)*(wt % MTBE/2.7))	Buta/TOG = 0.0044 + ((0.0044* -0.2804)*(wt % EtOH/3.5))
LDGV and LDGT/noncat MC	Buta/TOG = 0.0092	Buta/TOG = 0.0092 + ((0.0092 * 0.1517)*(wt % MTBE/2.7))	Buta/TOG = 0.0092 + ((0.0092 * 0.1233)*(wt % EtOH/3.5))
HDGV/noncat	Buta/TOG = 0.0074	Buta/TOG = 0.0074 + ((0.0074 * -0.2172)*(wt % MTBE/2.7))	Buta/TOG = 0.0074 + ((0.0074 * 0.1233)*(wt % MTBE/2.7))
HDGV/cat	Buta/TOG = 0.0029	Buta/TOG = 0.0029 + ((0.0029 * -0.3233)*(wt % MTBE/2.7))	Buta/TOG = 0.0029 + ((0.0029 * -0.1188)*(wt % EtOH/3.5))
LDDV	Buta/TOG = 0.0090		
LDDT	Buta/TOG = 0.0090		
HDDV	Buta/TOG = 0.0061		

Vehicle Class/ Catalyst	Baseline Gasoline	MTBE Gasoline	EtOH Gasoline
MTBE			
LDGV and LDGT/oxcat		MTBE/TOG = 0.0464*(wt % MTBE/2.7)	
LDGV and LDGT/noncat MC		MTBE/TOG = 0.0333*(wt % MTBE/2.7)	
HDGV/noncat		MTBE/TOG = 0.0209*(wt % MTBE/2.7)	
HDGV/cat		MTBE/TOG = 0.0155*(wt % MTBE/2.7)	

Table 2.4. Light-Duty Gasoline Vehicle Off-Cycle Adjustments for Toxic/TOG Fractions

Toxic Compound	Normal Hydrocarbon Emitter	High Hydrocarbon Emitter
Benzene	1.315	1.126
1,3-Butadiene	1.037	0.708
MTBE	0.825	0.965
Formaldehyde	1.163	0.894
Acetaldehyde	1.020	0.919

2.2. Exhaust Emissions for Acrolein

Acrolein emissions were not included in MOBTOX5b, but the pollutant is included explicitly in MOBILE6.2 because it was identified as a national non-cancer hazard driver in the the National-Scale Air Toxics Assessment (more than 10% of the U.S. population lives in census tracts where the typical exposure exceeded the reference concentration for this compound),[8] and because highway mobile sources are a large contributor to the overall inventory in 1996.[7] Acrolein fractions of TOG used in the model are the same as those used in the 1996 National Toxics Inventory. The documentation for that inventory describes the data sources used to develop them.[9] The fractions used are provided in Table 2.5. They are obtained from vehicles running on a baseline gasoline or diesel fuel and the model does not account for potential impacts of fuel reformulation.

Table 2.5. Acrolein/TOG fractions Used in MOBILE6.2

Vehicle Category	Acrolein/TOG Fraction
LDGV	0.0006
LDGT	0.0006
HDGV – Catalyst	0.0005
HDGV – No Catalyst	0.0045
LDDV	0.0035
HDDV	0.0035
MC	0.0006

2.3 Evaporative Emissions for Benzene and MTBE

Algorithms from the Complex Model for Reformulated Gasoline and the MTBE draft fuel effects model were used to developed benzene and MTBE fractions of evaporative TOG.[10, 11] A summary of the algorithms used are given in Table 2.6. Since the above two models do not calculate resting loss emissions, it was assumed that benzene and MTBE fractions for resting loss were equal to those of diurnal emissions. The algorithms for benzene are based on a proprietary vapor equilibrium model developed by General Motors. For MTBE, diurnal and hot soak emission algorithms are based on regression analysis of data from over 100 tests; and the running loss algorithm is based on data from 6 tests. The refueling emissions algorithm is based on an analysis done at the Colorado School of Mines, which relates MTBE refueling emissions to benzene refueling emissions.[16] MOBILE6.2 does not estimate crankcase emissions of HAPs due to a lack of HAP emissions data on this emissions type.

Table 2.6. Evaporative Benzene and MTBE Fraction Equations from the Complex Model and EPA's MTBE Model

Pollutant	Process	Toxic Fraction Equation (Toxic/TOG)
Benzene	Hot Soak	(-0.03420*OXY - 0.080274*RVP + 1.4448)*BNZ/100
	Diurnal	(-0.02895*OXY - 0.080274*RVP + 1.3758)*BNZ/100
	Running	(-0.03420*OXY - 0.080274*RVP + 1.4448)*BNZ/100
	Resting	(-0.02895*OXY - 0.080274*RVP + 1.3758)*BNZ/100
	Refueling	(-0.02955*OXY - 0.081507*RVP + 1.3972)*BNZ/100
MTBE (High)	Hot Soak	(24.205 - 1.746*RVP)*MTBE/1000
	Diurnal	(22.198 - 1.746*RVP)*MTBE/1000
	Running	(17.8538 - 1.6622*RVP)*MTBE/1000
	Resting	(22.198 - 1.746*RVP)*MTBE/1000
	Refueling	1.743*MTBE*(-0.02955*OXY - 0.081507*RVP + 1.3972)/100

Note: OXY = wt% oxygen
RVP = Reid vapor pressure in psi
BNZ = vol% benzene
MTBE = vol% MTBE

2.4. User-Defined Air Toxic Pollutants

MOBILE6.2 has a command (AIR TOXICS EF) which allows the user to enter emission factors or air toxic ratios for additional air toxic pollutants. Table 2.7 lists compounds identified as mobile source air toxics in the 2000 Mobile Source Air Toxics Rule that are not explicitly modeled by MOBILE6.2 (benzene, ,13-butadiene, formaldehyde, acetaldehyde, MTBE and acrolein are modeled) or MOBILE6.1 (diesel particulate matter).

Table 2.7. List of Mobile Source Air Toxics (MSATs) Not Explicitly Modeled by MOBILE6.1 or MOBILE6.2.

Arsenic Compounds	Mercury Compounds
Chromium Compounds	Naphthalene[a]
Dioxin/Furans	Nickel Compounds
Ethylbenzene[a]	POM[b]
n–Hexane[a]	Styrene
Lead Compounds	Toluene[a]
Manganese Compounds	Xylene[a]

[a]Found in evaporative as well as exhaust emissions.
[b]Polycyclic Organic Matter includes organic compounds with more than one benzene ring, and which have a boiling point greater than or equal to 100 degrees centigrade. A group of seven polynuclear aromatic hydrocarbons, which have been identified by EPA as probable human carcinogens, (benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene) are sometimes used as surrogates for the larger group of POM compounds.

A number of these compounds have an evaporative as well as an exhaust emissions component. As described in the MOBILE6.2 User's Guide, emission factors must be input in milligrams per mile and ratios can be input as fractions of VOC, fractions of TOG, or fractions of PM. All user-defined inputs for evaporative emissions must be input as ratios. Emission factors and toxic fractions used in the development of Version 2 of the 1999 National Toxics Inventory can be found in the documentation for that inventory.[17]

3.0 Input Parameter Data

MOBILE6.2 requires the following additional fuel parameter inputs which are not required for estimation of criteria pollutant emissions:

GAS AROMATIC% – Aromatic content of gasoline on a percentage of total volume basis

GAS OLEFIN% – Olefin content of gasoline on a percentage of total volume basis

GAS BENZENE% – Benzene content of gasoline on a percentage of total volume basis

E200 – Percentage of vapor a given gasoline produces at 200 degrees F

E300 – Percentage of vapor a given gasoline produces at 300 degrees F

OXYGENATE – Oxygenate type and content of gasoline on a percentage of total volume basis. There are four valid oxygenate types in the model:

MTBE – methyl tertiary butyl ether
ETBE – ethyl tertiary butyl ether
ETOH – ethanol
TAME – tertiary amine methyl ether

These are all parameters included in the Complex Model. MOBILE6.2 cannot model air toxics in a situation where a single fuel contains more than one oxygenate. However, the user can model multiple fuels for an area which differ in the oxygenate used, using a "market share" parameter. This is described in more detail in the User's Guide. Also, if the user selects ETBE or TAME, MOBILE6 assumes that it is an equal weight percent of MTBE for the purposes of HC, CO, and NOx calculations.

3.1 Sources of Fuel Parameter Data for Modeling Base Years

There are a number of sources of data on fuel properties from surveys of gasoline at service stations. Information on these data sources is provided below.

3.1.1. The Alliance of Automobile Manufacturers North American Gasoline and Diesel Fuel Survey

The Alliance of Automobile Manufacturers samples commercially available gasoline and diesel fuel throughout the United States, Mexico, and Canada during the summer and winter seasons. In the U.S., three grades of gasoline are sampled – premium unleaded, mid-grade unleaded, and regular unleaded. Table 3.1 lists the U. S. cities included in the Alliance gasoline surveys. Information on obtaining the copyrighted survey data can be obtained from Ellen Shapiro at (202)326-5533.

3.1.2. TRW Petroleum Technologies Survey

TRW Petroleum Technologies (formerly the National Institute for Petroleum and Energy Research) also samples gasoline from service stations throughout the country during summer and winter. The TRW Petroleum Technologies surveys include non-reformulated gasoline, gasoline-alcohol blends, and reformulated gasolines. Data are reported for 3 grades, for 15 marketing districts, selected by elevation and location. Table 3.2 lists the marketing districts included in the surveys. Information on obtaining surveys can be obtained from the following address:

TRW Petroleum Technologies
Attn: Cheryl L. Dickson
P. O. Box 2543
Batlesville, OK 74005
Telephone: (918)338-4419

Table 3.1. Cities Included in Fuel Surveys Conducted by the Alliance of Automobile Manufacturers

Albuquerque, NM	Fairbanks, AK**	Philadelphia, PA
Atlanta, GA	Houston, TX*	Phoenix, AZ
Billings, MT	Kansas City, MO	Pittsburgh, PA*
Boston, MA	Las Vegas, NV	St. Louis, MO
Chicago, IL	Los Angeles, CA	San Antonio, TX
Cleveland, OH	Miami, FL	San Francisco, CA
Dallas, TX	Minneapolis/ St. Paul, MN	Seattle, WA
Denver, CO	New Orleans, LA	Washington, DC
Detroit, MI	New York City, NY	

*Data collection initiated in 1994.
**Data collection initiated in 2000.

3.1.3. Reformulated Gasoline Surveys

The U.S. EPA samples gasoline at the pump in reformulated gasoline areas, at least four times a year, twice during the summer VOC season (6/1-9/15) and twice outside the VOC season. Mandatory reformulated gasoline areas outside California are surveyed at least eleven times a year. Some of the smallest opt-in areas are not surveyed every year. Surveys measure complex model parameters plus T50 and T90, except that surveys in the federal RFG areas in California are for oxygenates only. At present, information on obtaining survey data can be obtained from Stuart Romanow, U.S. EPA, Office of Transportation and Air Quality, Regional and State Programs Division, 202-564-9296. EPA has plans to make these data available on the World Wide Web in the near future.

3.2 Weighting Fuel Parameter Data from Surveys

For most modeling, it will be necessary to develop composite fuel parameters based on the mix of regular, mid-grade, and premium gasoline. Such data can be found at the State level in the Petroleum Marketing Annual reports, published by the Energy Information Administration, Office of Oil and Gas, Department of Energy. These documents can be found at the following website:

http://www.eia.doe.gov/oil_gas/petroleum/data_publications/petroleum_marketing_annual/pma_historical.html

Table 3.2. Districts Included in TRW Petroleum Technologies Gasoline Surveys

District	States
1 (Northeast)	Connecticut, Massachusetts, New Jersey, New York, Pennsylvania, Rhode Island
2 (Mid-Atlantic Coast)	Washington, DC, Maryland, Virginia
3 (Southeast)	Alabama, Arkansas, Georgia, Louisiana, North Carolina, South Carolina, Tennessee
4 (Florida)	
5 (North Central)	Northern Illinois, Michigan, Minnesota, Wisconsin
6 (Ohio Valley)	Indiana, Kentucky, West Virginia, Ohio
7 (Central and Upper Plains)	North Dakota, South Dakota, Nebraska, Kansas, Iowa, Missouri, Southern Illinois
8 (Oklahoma and East Texas)	
9 (North Mountain States)	Montana, Wyoming, Eastern Washington, Eastern Oregon
10 (Central Mountain States)	Colorado, Utah
11 (New Mexico, West Texas)	
12 (West Southwest)	Arizona, Southern Nevada, Southeastern CA
13 (Pacific Northwest)	Western Washington, Western Oregon
14 (North California and North Nevada)	
15 (South California)	

3.3. Projecting Fuel Parameters to Future Years

In order to do toxic emission factor modeling for future years, model users will need to make a determination of appropriate fuel parameters to use in the modeling. There are three potential approaches which may be used to do this:

1) Use existing refinery modeling work and apply results to areas being modeled.

2) Employ a consultant to evaluate what fuel changes are likely, based on professional judgement and experience, or to do new refinery modeling work.

3) If one is modeling an area where a new program has been implemented, look at other areas of the country where the program has been implemented, and make inferences.

Several refinery modeling studies were done in conjunction with the Tier 2/ Gasoline Sulfur Final Rulemaking, to evaluate costs of meeting low sulfur standards. These studies were done by the American Petroleum Institute, the National Petrochemical and Refiners Association, the Association of International Automobile Manufacturers, and the Department of Energy. Results of these studies are summarized Chapter 5 of the Regulatory Impact Analysis for the rule.[5]

3.4. Fuel Parameter Data from Recent EPA Toxic Emissions Modeling

In its 1999 assessment of motor vehicle toxic emissions and exposure,[3] EPA compiled fuel summer and winter parameters for 10 urban areas and 15 regions, which were used to develop emission factors for construction of a nationwide highway mobile source toxics inventory. Data were compiled for 1990 and 1996 base years, summer and winter. Projections to 2007 and 2020 were done based on refinery modeling. Methods use to do projections are described in Appendix J of the 1999 assessment. The parameters used in this modeling are provided in the Appendix of this guidance document.

4.0 Results of the MOBILE6.2 Model

4.1 Comparison of Calendar Year Fleet Average Emission Factors to MOBTOX5b Emission Factors from 1999 Study

This section presents some limited results of emission factor modeling using MOBILE6.2, comparing estimates to those from MOBTOX5b, the predecessor to this model. The MOBTOX5b emission factors were obtained from analyses done for the 1999 document, "Analysis of the Impacts of Control Programs on Motor Vehicle Toxics Emissions and Exposure in Urban Areas and Nationwide."[3] These emission factors do not include impacts of 2007 heavy duty standards. The MOBILE6.2 toxic emission factors were developed using the same input data, again not including impacts of 2007 heavy duty standards. The limited results presented here are based on modeling for the city of Atlanta. Atlanta does not have a reformulated gasoline program but does have an inspection and maintenance program. Although absolute emission levels vary significantly from city to city, depending on type of fuel program, type of inspection and maintenance program, average temperature and other local parameters, the trends in toxic emissions are consistent. Thus modeling results for Atlanta are a good illustration of the directional differences which can be anticipated in changing between the models.

Figures 4.1 through 4.4 present fleet average toxic emission factors from MOBTOX5b

and MOBILE6.2, for benzene, 1,3-butadiene, formaldehyde, and acetaldehyde. For all compounds, MOBILE6.2 estimates higher emission factors in base years, with a convergence in emission factors by 2020. This trend is primarily a result of changes in the TOG emission rates used in MOBILE6.2, versus those used in MOBTOX5b. The TOG emission rates in MOBTOX5b were derived incorporating elements of the MOBILE6 methodology, but significant revisions to the emission rates were made subsequent to the development of MOBTOX5b and prior to release of MOBILE6. The difference in underlying TOG emission rates between the two models are given in Figure 4.5.

Figure 4.1. MOBILE6.2 and MOBTOX5b Comparison for Benzene (fleet average, exhaust and evaporative)

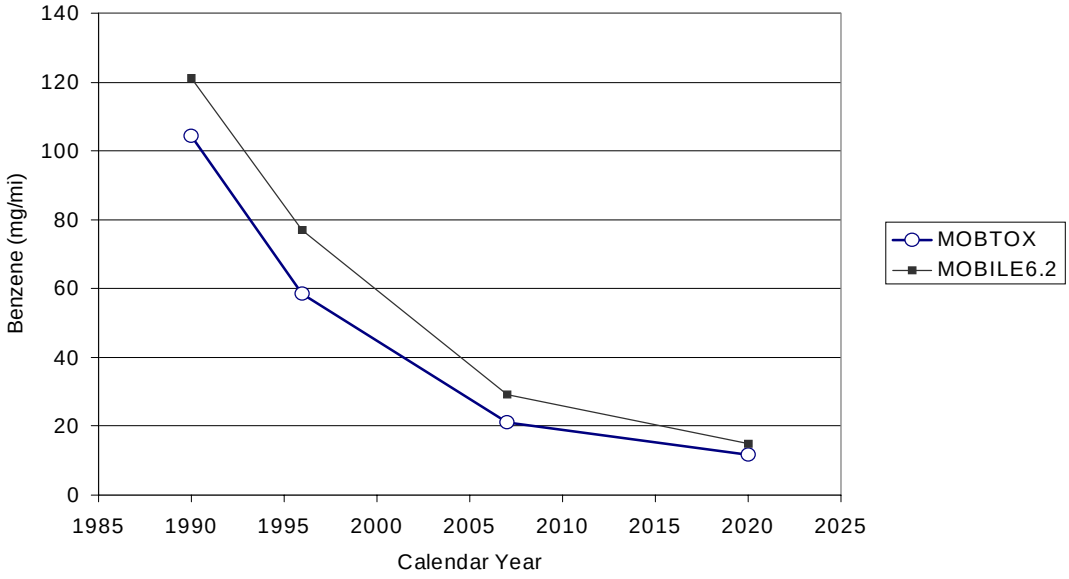


Figure 4.2. MOBILE6.2 and MOBTOX5b Comparison for 1,3-Butadiene (fleet average)

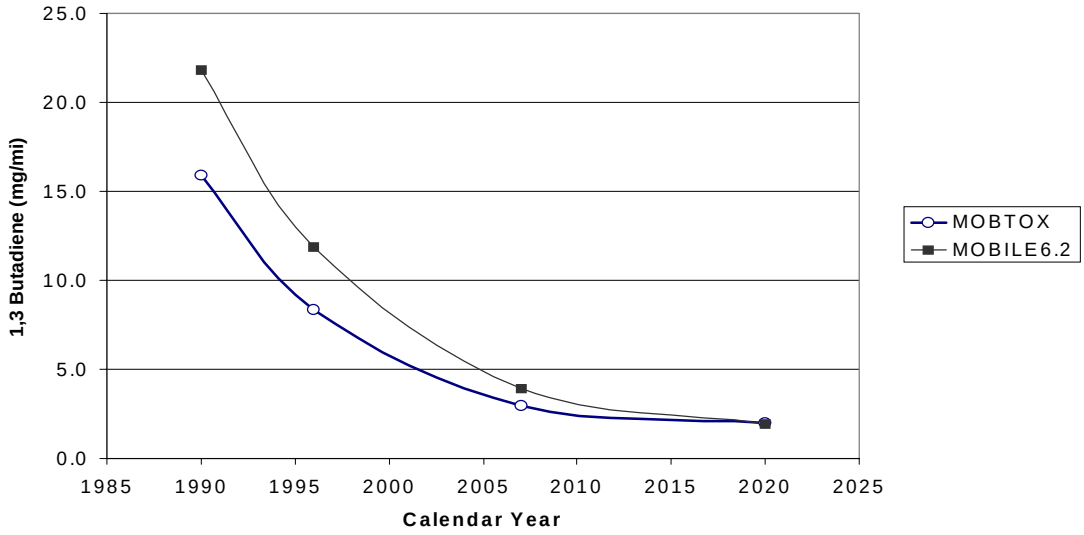


Figure 4.3. MOBILE6.2 and MOBTOX5b Comparison for Formaldehyde (fleet average)

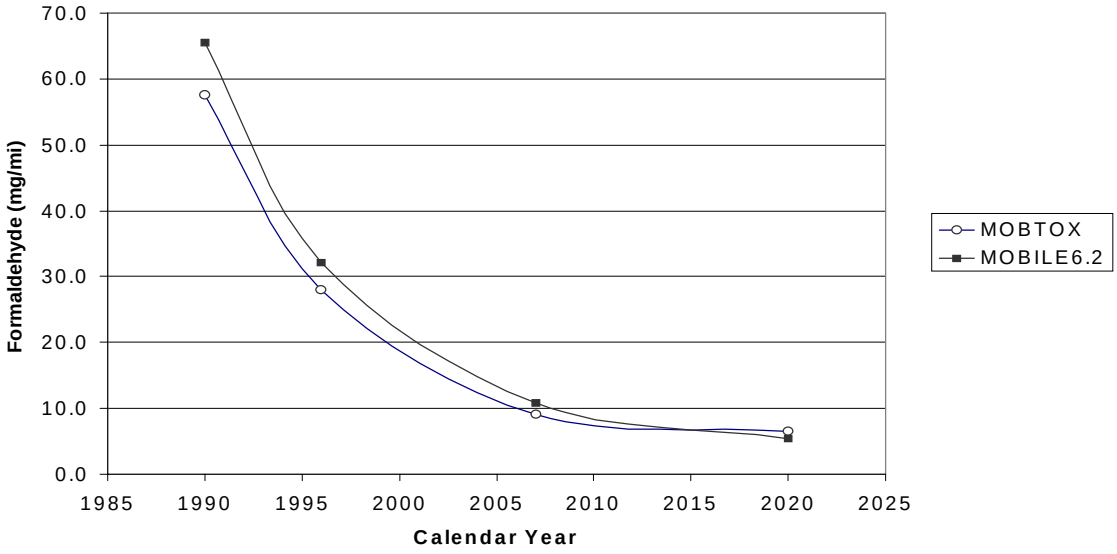


Figure 4.4. MOBILE6.2 and MOBTOX5b Comparison for Acetaldehyde (fleet average)

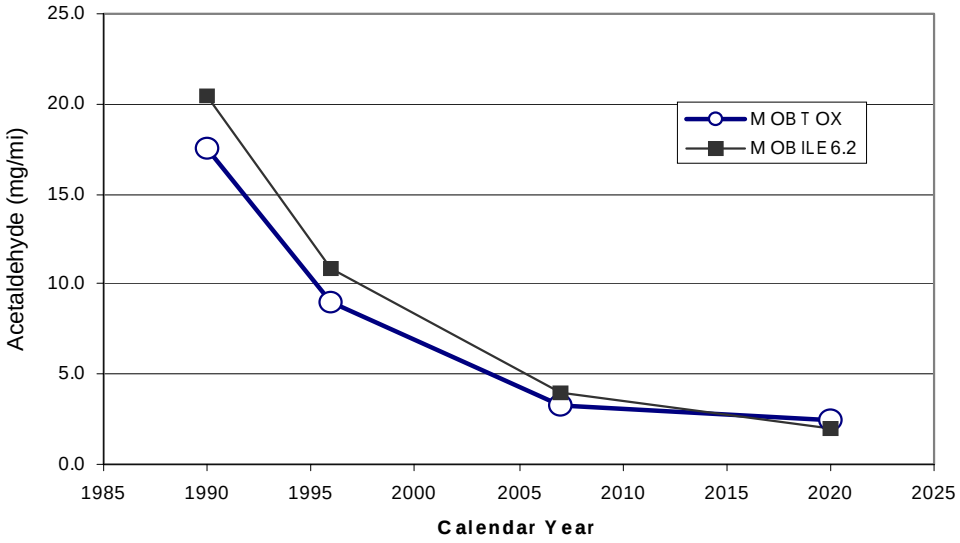
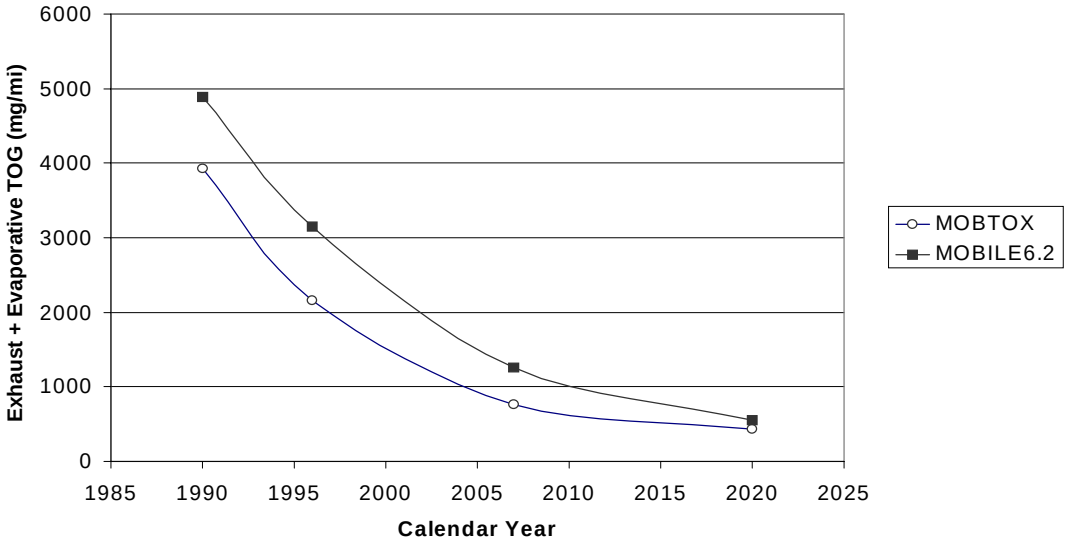


Figure 4.5. MOBILE6.2 and MOBTOX5b Comparison for TOG Emissions (Exhaust and Evaporative)



In base years (around CY 1990), the difference between MOBILE6.2 and MOBTOX5b is greatest for 1,3-butadiene. This is because during base years, MOBILE6.2 classifies more vehicles as hydrocarbon high emitters, and the toxic to TOG fraction for 1,3-butadiene is roughly three times higher than the normal emitter fraction. It should also be noted that MOBILE6.2 projects slightly lower emission factors for formaldehyde and acetaldehyde by 2020. This is because diesel vehicles emit proportionally larger quantities of carbonyl compounds relative to TOG, and MOBILE6 projects lower TOG emissions for heavy duty diesel engines, particularly in future years when benefits of 2007 heavy duty standards are realized.

4.2 Comparison of MOBILE6.2 and MOBTOX5b Results by Vehicle Class and Model Year

As part of an evaluation of MOBILE6.2 modeling results, Eastern Research Group, Inc. developed an Excel Workbook which can generate charts which can make MOBILE6.2 versus MOBTOX5b comparisons for the following cases:

4) Atlanta, Chicago, and Los Angeles
5) 1990, 2007, and 2020
6) Winter and Summer

The workbook allows comparison of exhaust and evaporative toxic and TOG emission factors, as well as toxic to TOG ratios, for individual vehicles classes. Results are presented by model year

for a given calendar year. Since MOBILE6.2 and MOBTOX5b use different classes of vehicles, the comparisons in Table 4.1 were used.

Table 4.1. Classes of Vehicle Types Compared Between MOBILE6.2 and MOBTOX5b

MOBILE5/ MOBTOX Vehicle Type	MOBTOX Vehicle Type ID Number	MOBILE6 Vehicle Type	MOBILE6 Vehicle Type ID Number
LDGV	1	LDGV	1
LDGT2	3	LDGT3	4
HDGV	4	HDGV2b	6
LDDV	5	LDDV	14
HDDV	7	HDDV8B	23

Figures 4.6 and 4.7 depict mg/mi emission factors and toxic to TOG ratios, respectively, for light-duty gasoline vehicle exhaust benzene in Atlanta, summer, 2007, by model year. MOBILE6.2 emission factors for early 1980's model years are about three times greater than MOBTOX5b, while there is convergence for later model years. Benzene to TOG ratios are also somewhat higher for earlier model years, but the difference is not as great as the difference in emission factors. Thus, it can be concluded that differences in TOG emission rates for earlier model years account for most of the difference in benzene emission rates (Figure 4.8).

Figure 4.6. Light Duty Gasoline Vehicle mg/mi Benzene Exhaust Emission Factors for Atlanta, Summer, 2007.

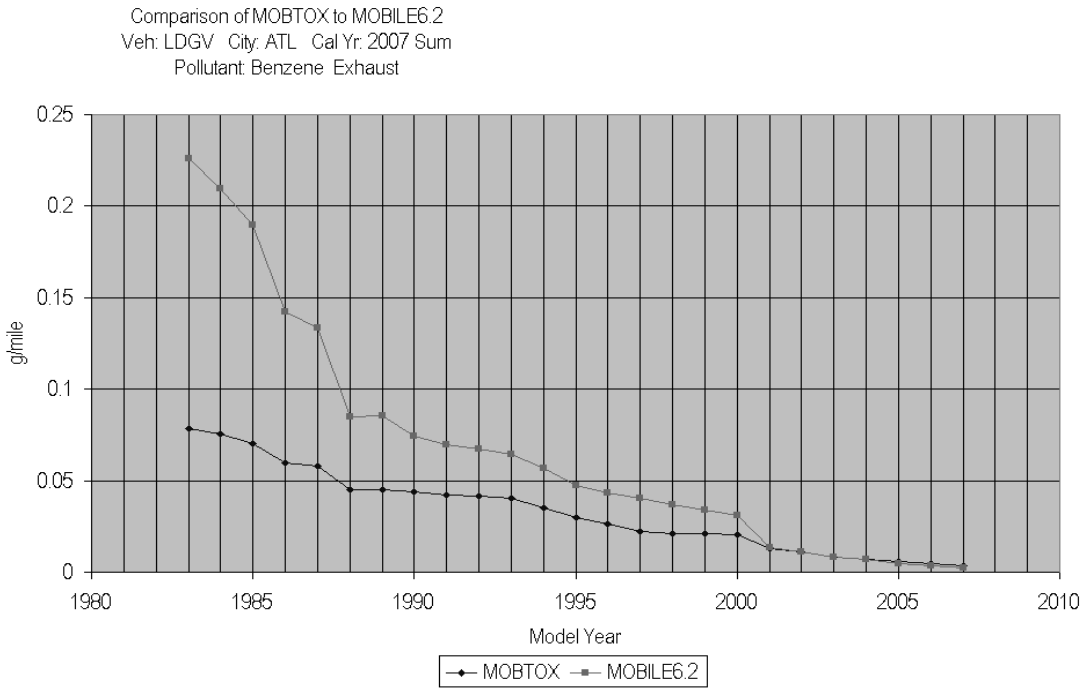


Figure 4.7. Light Duty Gasoline Vehicle Benzene Exhaust fractions of TOG for Atlanta, Summer, 2007.

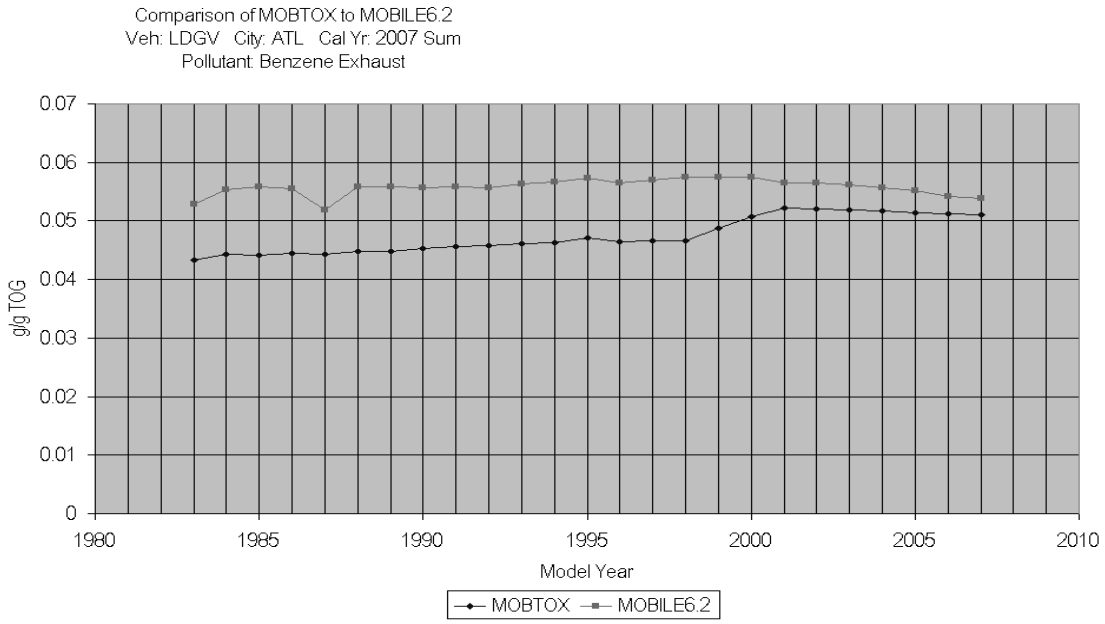
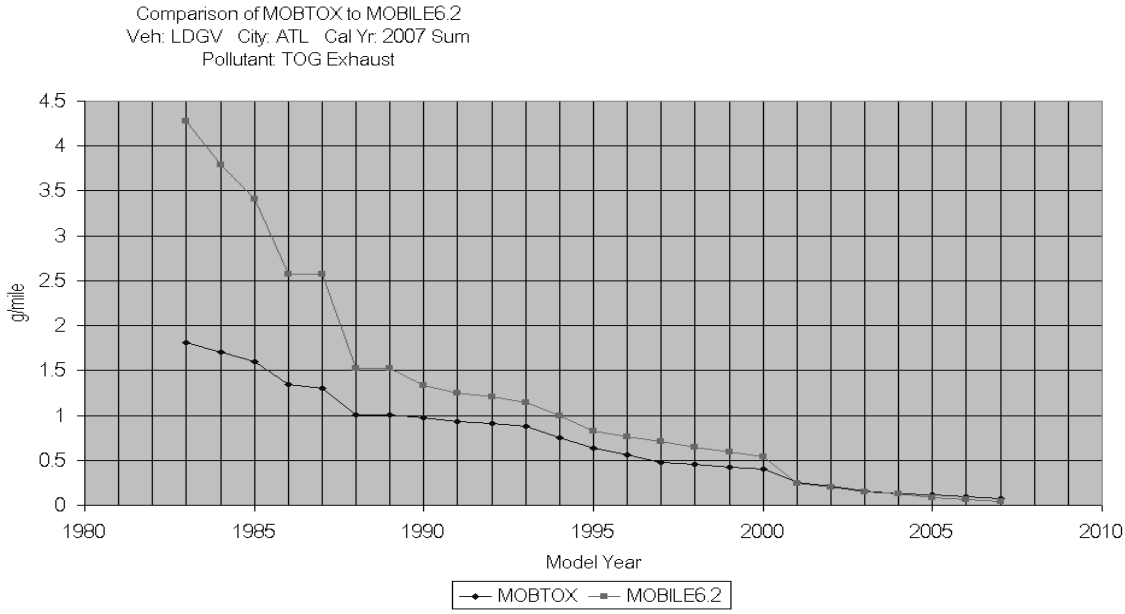


Figure 4.8. Light Duty Gasoline Vehicle Exhaust g/mi TOG for Atlanta, Summer, 2007.



A similar trend is seen in benzene evaporative emission rates (Figure 4.9). For heavy duty diesel vehicles, however, benzene exhaust emission rates estimated using MOBILE6.2 are lower than MOBTOX5b (Figure 4.10). This is a result of lower TOG emission rates in MOBILE6.2 for that vehicle class.

The Excel workbook used to make these comparisons for benzene, as well as comparisons for other HAPs, has been made available along with the release of the document (file name External_ChartComparisons_20011120.xls).

Figure 4.9. Light Duty Gasoline Vehicle Evaporative Benzene mg/mi for Atlanta, Summer, 2007.

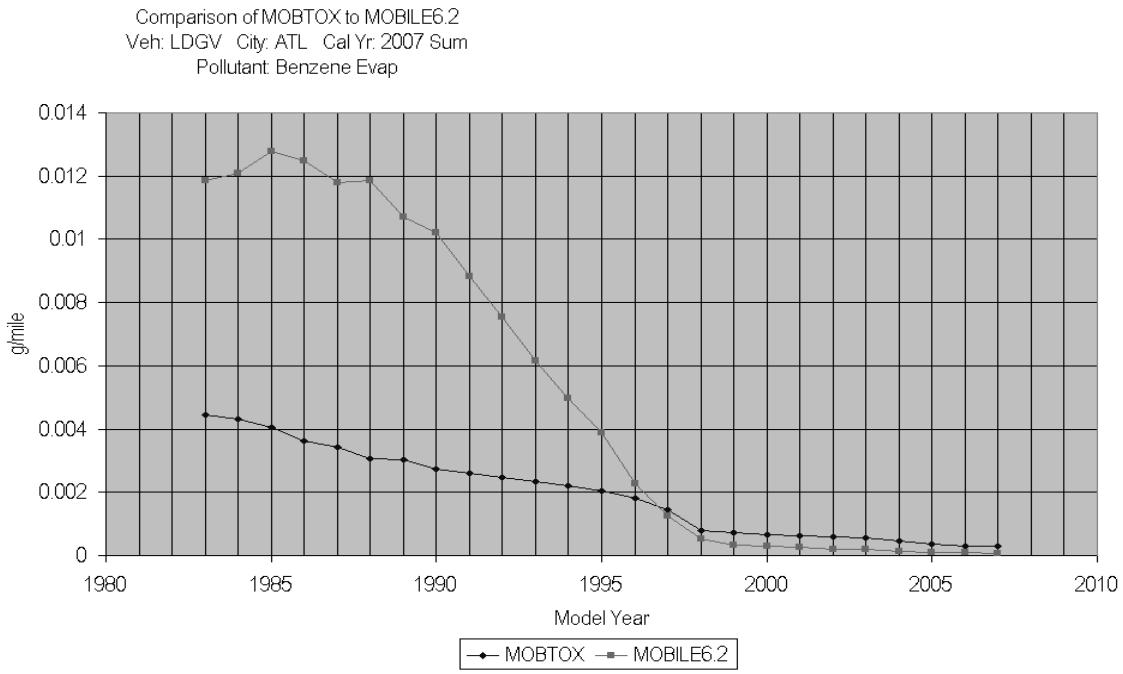
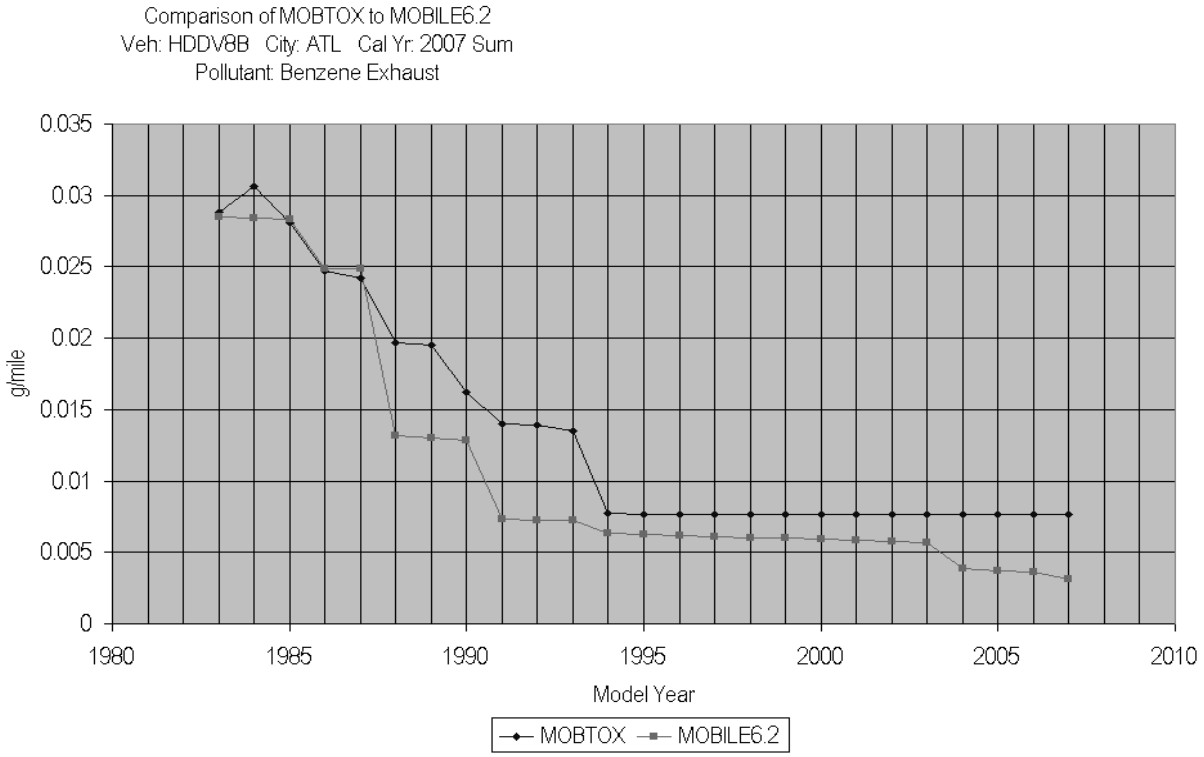


Figure 4.10. Heavy Duty Diesel Vehicle Exhaust Benzene mg/mi for Atlanta, Summer, 2007.



5.0 References

1. EPA. 1993. Motor Vehicle-Related Air Toxics Study. Office of Mobile Sources, Ann Arbor, MI. Report No. EPA 420-R-93-005, April. http://www.epa.gov/otaq/toxics.htm

2. Cook, R., P. Brodowicz, D. Brzezinski, P. Heirigs, and S. Kishan. 1998. Analysis of In-Use Motor Vehicle Toxic Emissions Using a New Emission Factor Model, MOBTOX5b. Presented at AWMA Specialty Conference, Emission Inventory: Living in a Global Environment, December 8-10, 1998.

3. EPA. 1999. Analysis of the Impacts of Control Programs on Motor Vehicle Toxics Emissions and Exposure in Urban Areas and Nationwide. Prepared for U. S. EPA, Office of Transportation and Air Quality, by Sierra Research, Inc., and Radian International Corporation/Eastern Research Group. Report No. EPA 420 –R-99-029/030. http://www.epa.gov/otaq/regs/toxics/r99029.pdf

4. Cook, R., P. Brodowicz, P. Heirigs, S. Kishan, and M. Weatherby. 2000. Assessment of Emissions and Exposure from Selected Motor Vehicle Air Toxics. Paper No. 77, Presented at 93rd Annual AWMA Conference, Salt Lake City, UT, June 18-22, 2000.

5. EPA. 1999. Regulatory Impact Analysis - Control of Air Pollution from New Motor Vehicles: Tier 2 Motor Vehicle Emissions Standards and Gasoline Sulfur Control. Report No. EPA420-R-99-023, December 1999.
http://www.epa.gov/otaq/regs/ld-hwy/tier-2/frm/ria/r99023.pdf

6. EPA. 2000. Regulatory Impact Analysis: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements. Report No. EPA420-R-00-026, December 2000. http://www.epa.gov/otaq/diesel.htm

7. EPA. 2000. Technical Support Document. Control of Hazardous Air Pollutants from Motor Vehicles and Motor Vehicle Fuels. EPA Office of Transportation and Air Quality, December 2000. Report No. EPA-420-R-00-023. http://www.epa.gov/otaq/regs/toxics/r00023.pdf

8. EPA. 2001a. National-Scale Air Toxics Assessment for 1996. Draft for EPA Science Advisory Board Review. EPA Office of Air Quality Planning and Standards, January 18, 2001. Report No. EPA-453/R-01-003. http://www.epa.gov/ttn/atw/sab/sabrev.html#A1

9. Eastern Research Group. 2000a. Documentation for the 1996 Base Year National Toxics Inventory for Onroad Sources. Prepared for U. S. EPA, Emission Factor and Inventory Group, Office of Air Quality Planning and Standards, June 2, 2000. http://www.epa.gov/ttn/chief/nti/

10. EPA. 1993. Final Regulatory Impact Analysis for Reformulated Gasoline. December 13, 1993. http://www.epa.gov/otaq/regs/fuels/rfg/ (ria.zip)

11. Wyborny, L. 1998. Methyl Tertiary Butyl Ether (MTBE) Emissions from Passenger Cars. Draft Technical Report. U. S. Environmental Protection Agency, Office of Mobile Sources. April, 1998.

12. National Research Council. 2000. Modeling Mobile Source Emissions. National Academy Press, Washington, DC. http://www.nap.edu/books/0309070880/html/

13. Coordinating Research Council. 1997. Test Program to Determine Fuel Sulfur Effect on Emissions from California Low-Emission Vehicles. Project E-42.

14. EPA. 1998. Emission Control Technology Distributions: Current and Projected Use of Emission Control Technology in Light and Heavy Duty Engines. EPA Report No. 420-98-013, MOBILE6 Document No. M6.FLT.008. http://www.epa.gov/otaq/models/mobile6/m6flt008.pdf

15. EPA. 2001. Stategies and Issues in Correlating Diesel Fuel Properties with Emissions: Staff Discussion Document. EPA Report No. 420-P-01-001.
http://www.epa.gov/otaq/models/analysis/p01001.pdf

16. Grabowski, Michael S., Mowery, Deborah L., McClelland, John W.; Draft Report: Microenvironment and Source Apportionment Analysis of Toxics Exposure from Conventional and Oxygenated Motor Fuels;" Colorado School of Mines, September 1997.

17. Eastern Research Group. 2001. Documentation for the Draft 1999 Base Year Onroad National Emission Inventory for Hazardous Air Pollutants. Prepared for Emission Factor and Inventory Group, Office of Air Quality Planning and Standards, October 15, 2001.

Appendix -- 1990 Baseline Fuel Specifications

Area	Abbrev.	Year	Season	RVP, psi	Aromatics	Olefins	Benzene %	Sulfur	E200 %	E300 %	MTBE %	ETBE %	EtOH %	TAME %	Oxygen wt %
Atlanta	AT	1990	Summer	8.5	27.9	10.5	1.16	344	40.7	79.0	0.0	0.0	0.0	0.0	0.00
Atlanta	AT	1990	Winter	12.5	26.2	14.4	1.49	267	49.1	82.4	0.0	0.0	0.0	0.0	0.00
Chicago	CH	1990	Summer	8.7	28.8	8.6	1.35	512	47.2	78.6	0.0	0.0	0.0	0.0	0.00
Chicago	CH	1990	Winter	13.7	23.0	9.1	1.69	450	54.4	82.6	0.0	0.0	0.0	0.0	0.00
Denver	DN	1990	Summer	8.3	24.8	12.2	1.41	375	45.1	79.4	0.0	0.0	0.0	0.0	0.00
Denver	DN	1990	Winter	12.1	19.3	12.8	1.23	272	62.0	85.5	11.6	0.0	0.0	0.0	2.06
Houston	HS	1990	Summer	8.3	30.2	10.9	1.36	375	46.7	79.4	0.5	0.0	0.0	0.0	0.10
Houston	HS	1990	Winter	12.8	23.0	14.4	1.22	454	52.4	80.2	0.0	0.0	0.0	0.0	0.00
Minneapolis	MN	1990	Summer	9.5	29.8	8.3	1.69	422	45.9	78.9	0.0	0.0	0.0	0.0	0.00
Minneapolis	MN	1990	Winter	13.2	24.9	9.3	1.86	701	56.0	81.6	0.0	0.0	0.0	0.0	0.00
New York	NY	1990	Summer	8.3	31.9	13.9	1.08	367	43.1	78.8	2.4	0.0	0.0	0.0	0.42
New York	NY	1990	Winter	13.3	26.4	16.7	1.55	274	49.5	81.8	0.0	0.0	0.0	0.0	0.00
Philadelphia	PA	1990	Summer	8.4	29.2	13.7	0.86	371	43.6	79.0	0.0	0.0	0.0	0.0	0.00
Philadelphia	PA	1990	Winter	13.9	23.5	13.2	1.63	206	50.5	82.9	0.0	0.0	0.0	0.0	0.00
Phoenix	PX	1990	Summer	8.1	33.0	5.9	2.15	123	41.1	78.5	0.0	0.0	0.0	0.0	0.00
Phoenix	PX	1990	Winter	10.9	26.4	5.6	1.88	157	56.5	82.9	11.4	0.0	0.0	0.0	2.04
Spokane	SP	1990	Summer	8.6	21.0	8.0	1.36	739	46.6	82.6	0.0	0.0	0.0	0.0	0.00
Spokane	SP	1990	Winter	13.1	19.2	10.3	1.58	698	51.1	84.9	0.0	0.0	0.0	0.0	0.00
St. Louis	SL	1990	Summer	8.8	28.9	8.9	1.11	372	45.2	78.9	0.0	0.0	0.0	0.0	0.00
St. Louis	SL	1990	Winter	13.2	22.0	11.4	1.71	319	54.0	82.7	0.0	0.0	0.0	0.0	0.00
Western WA/OR - Win 95/96	WA	1990	Summer	9.4	29.0	10.0	2.34	449	43.5	81.0	1.8	0.0	0.0	0.0	0.32
Western WA/OR - Win 95/96	WA	1990	Winter	12.9	30.9	8.2	2.47	314	49.7	83.7	0.5	0.0	0.0	0.0	0.08
Western WA/OR - Win 96/97	WB	1990	Summer	9.4	29.0	10.0	2.34	449	43.5	81.0	1.8	0.0	0.0	0.0	0.32
Western WA/OR - Win 96/97	WB	1990	Winter	12.9	30.9	8.2	2.47	314	49.7	83.7	0.5	0.0	0.0	0.0	0.08
Northern California	CN	1990	Summer	8.3	29.9	11.5	2.17	104	41.8	82.2	0.0	0.0	0.0	0.0	0.00
Northern California	CN	1990	Winter	12.4	29.9	9.6	2.14	135	49.3	84.3	0.5	0.0	0.0	0.0	0.08
Southern California	CS	1990	Summer	8.2	29.1	7.6	2.12	172	40.8	80.8	2.8	0.0	0.0	0.0	0.50
Southern California	CS	1990	Winter	11.3	29.8	8.6	1.81	205	45.9	82.6	0.5	0.0	0.0	0.0	0.08
ID/MT/WY	ID	1990	Summer	9.3	24.6	9.9	1.98	565	47.5	84.1	0.2	0.0	0.0	0.0	0.04
ID/MT/WY	ID	1990	Winter	13.0	22.5	13.7	1.71	681	53.6	86.5	0.5	0.0	0.0	0.0	0.09
UT/NM/NV	UT	1990	Summer	8.7	23.7	11.0	1.97	235	44.6	82.8	1.3	0.0	0.0	0.0	0.22
UT/NM/NV	UT	1990	Winter	13.0	23.5	13.5	2.13	159	56.3	87.4	0.0	0.0	0.0	16.5	2.70
ND/SD/NE/IA/KS/Western MO	ND	1990	Summer	8.8	26.6	9.6	1.50	328	47.4	81.3	0.7	0.0	1.5	0.0	0.64
ND/SD/NE/IA/KS/Western MO	ND	1990	Winter	13.3	21.0	10.8	1.29	307	55.3	84.6	0.8	0.0	1.6	0.0	0.70
AR/MS/AL/SC/Northern LA	SE	1990	Summer	8.6	28.8	12.8	1.62	363	43.0	79.5	1.5	0.0	0.0	0.0	0.27
AR/MS/AL/SC/Northern LA	SE	1990	Winter	12.3	25.6	16.9	1.47	328	50.0	81.6	1.2	0.0	0.0	0.0	0.22
Florida	FL	1990	Summer	9.2	31.6	9.0	1.40	363	44.1	79.2	1.5	0.0	0.0	0.0	0.27
Florida	FL	1990	Winter	12.2	26.0	17.7	1.25	372	48.9	80.3	1.2	0.0	0.0	0.0	0.21
Northeast-NoRFG	NN	1990	Summer	8.8	29.7	13.7	1.77	332	42.5	80.4	1.1	0.0	0.0	0.0	0.19
Northeast-NoRFG	NN	1990	Winter	13.5	26.5	17.3	1.42	343	51.6	82.9	1.2	0.0	0.0	0.0	0.22
Northeast-RFG	NR	1990	Summer	8.8	29.7	13.7	1.77	332	42.5	80.4	1.1	0.0	0.0	0.0	0.19
Northeast-RFG	NR	1990	Winter	13.5	26.5	17.3	1.42	343	51.6	82.9	1.2	0.0	0.0	0.0	0.22
Ohio Valley-NoRFG	ON	1990	Summer	9.7	26.8	10.5	1.59	383	46.8	80.3	1.3	0.0	2.0	0.0	0.93
Ohio Valley-NoRFG	ON	1990	Winter	14.1	24.9	11.1	1.56	333	55.6	82.6	0.9	0.0	2.0	0.0	0.84
Ohio Valley-RFG	OR	1990	Summer	9.7	26.8	10.5	1.59	383	46.8	80.3	1.3	0.0	2.0	0.0	0.93
Ohio Valley-RFG	OR	1990	Winter	14.1	24.9	11.1	1.56	333	55.6	82.6	0.9	0.0	2.0	0.0	0.84
Northern MI/WI	MI	1990	Summer	9.4	27.1	8.5	1.57	363	49.2	80.8	2.5	0.0	1.8	0.0	1.06
Northern MI/WI	MI	1990	Winter	14.0	24.5	9.6	1.36	352	55.8	83.4	5.4	0.0	1.9	0.0	1.62
West Texas	WT	1990	Summer	8.0	28.6	9.6	1.83	289	45.3	81.4	2.4	0.0	0.0	0.0	0.43
West Texas	WT	1990	Winter	11.7	27.2	14.6	1.75	362	49.2	82.8	5.2	0.0	0.0	0.0	0.93

Appendix -- 1996 Baseline Fuel Specifications

Area	Abbrev.	Year	Season	RVP, psi	Aromatics	Olefins	Benzene %	Sulfur	E200 %	E300 %	MTBE %	ETBE %	EtOH %	TAME %	Oxygen wt
Atlanta	AT	1996	Summer	7.2	32.1	11.2	0.87	343	36.9	79.8	0.7	0.0	0.0	0.0	0.13
Atlanta	AT	1996	Winter	12.4	24.8	13.0	0.77	447	51.2	82.7	0.3	0.0	0.0	0.0	0.06
Chicago	CH	1996	Summer	7.9	26.0	9.7	0.96	492	50.2	80.8	0.0	0.0	9.0	0.0	3.12
Chicago	CH	1996	Winter	14.0	22.4	7.8	0.80	523	58.0	83.9	0.0	0.0	9.0	0.0	3.11
Denver	DN	1996	Summer	8.8	27.1	8.8	1.33	296	50.1	83.1	0.0	0.0	0.0	0.0	0.00
Denver	DN	1996	Winter	13.6	21.9	9.2	0.94	350	62.1	88.1	0.0	0.0	8.4	0.0	2.91
Houston	HS	1996	Summer	7.1	27.4	13.0	0.71	261	47.8	79.8	9.8	0.0	0.0	0.0	1.74
Houston	HS	1996	Winter	12.8	21.1	12.8	0.70	224	59.9	83.8	7.9	0.0	0.0	0.0	1.41
Minneapolis	MN	1996	Summer	9.6	28.2	7.3	1.81	121	59.4	84.6	0.0	0.0	9.4	0.0	3.24
Minneapolis	MN	1996	Winter	14.9	23.4	5.3	1.65	70	62.3	89.1	0.0	0.0	8.0	0.0	2.77
New York	NY	1996	Summer	8.0	28.6	17.1	0.51	231	49.8	81.5	10.6	0.0	0.0	0.0	1.89
New York	NY	1996	Winter	13.2	23.3	16.6	0.47	267	57.5	85.7	14.5	0.0	0.0	0.0	2.58
Philadelphia	PA	1996	Summer	7.9	29.0	12.3	0.80	367	51.2	81.8	11.3	0.0	0.0	0.0	2.01
Philadelphia	PA	1996	Winter	13.5	25.4	10.2	0.63	337	59.3	85.9	8.8	0.0	0.0	0.0	1.58
Phoenix	PX	1996	Summer	6.8	36.1	6.8	1.07	118	45.7	76.2	0.8	0.0	0.0	0.0	0.14
Phoenix	PX	1996	Winter	8.7	34.3	7.1	1.40	216	50.2	82.6	0.0	0.0	10.2	0.0	3.53
Spokane	SP	1996	Summer	8.7	28.5	8.3	1.32	412	45.0	81.4	0.0	0.0	0.0	0.0	0.00
Spokane	SP	1996	Winter	14.8	18.6	6.9	0.97	350	59.8	87.1	0.0	0.0	9.3	0.0	3.21
St. Louis	SL	1996	Summer	6.8	29.9	12.0	0.70	492	39.0	78.8	0.0	0.0	0.0	0.0	0.00
St. Louis	SL	1996	Winter	13.6	23.8	11.4	0.89	535	52.7	82.6	0.0	0.0	0.0	0.0	0.00
Western WA/OR - Win 95/96	WA	1996	Summer	8.0	35.7	6.7	2.17	256	44.0	82.4	0.1	0.0	0.0	0.0	0.02
Western WA/OR - Win 95/96	WA	1996	Winter	13.6	27.5	6.3	1.81	342	58.8	84.5	0.0	0.0	4.3	0.0	1.49
Western WA/OR - Win 96/97	WB	1996	Summer	8.0	35.7	6.7	2.17	256	44.0	82.4	0.1	0.0	0.0	0.0	0.02
Western WA/OR - Win 96/97	WB	1996	Winter	13.4	29.4	5.8	1.81	345	52.7	84.0	0.0	0.0	1.3	0.0	0.44
Northern California	CN	1996	Summer	6.9	24.4	3.5	0.56	26	49.3	89.9	9.1	0.0	0.0	0.0	1.63
Northern California	CN	1996	Winter	10.5	20.1	2.1	0.52	30	54.4	90.8	10.5	0.0	0.0	0.0	1.87
Southern California	CS	1996	Summer	7.0	20.7	4.3	0.52	10	51.0	86.8	11.0	0.0	0.0	0.0	1.96
Southern California	CS	1996	Winter	10.6	17.7	3.5	0.57	31	56.3	88.6	11.6	0.0	0.0	0.0	2.08
ID/MT/WY	ID	1996	Summer	8.5	28.3	8.1	1.64	318	46.8	84.6	0.5	0.0	0.0	0.0	0.09
ID/MT/WY	ID	1996	Winter	13.5	22.8	6.4	1.40	252	53.7	84.6	0.5	0.0	0.0	0.0	0.09
UT/NM/NV	UT	1996	Summer	8.0	30.7	10.6	1.75	207	45.2	83.6	1.1	0.0	0.0	0.0	0.20
UT/NM/NV	UT	1996	Winter	14.4	20.4	8.3	1.14	106	72.2	85.2	0.0	0.0	10.3	0.0	3.54
ND/SD/NE/IA/KS/Western MO	ND	1996	Summer	8.3	29.0	8.0	1.33	229	45.4	81.8	0.1	0.0	1.7	0.0	0.59
ND/SD/NE/IA/KS/Western MO	ND	1996	Winter	13.4	22.4	6.8	1.12	224	56.0	85.0	0.4	0.0	1.8	0.0	0.68
AR/MS/AL/SC/Northern LA	SE	1996	Summer	7.7	30.7	13.2	0.84	349	38.8	78.1	0.5	0.0	0.0	0.0	0.08
AR/MS/AL/SC/Northern LA	SE	1996	Winter	12.2	24.5	13.0	0.81	271	50.5	82.3	0.4	0.0	0.0	0.0	0.08
Florida	FL	1996	Summer	7.6	33.6	10.1	0.79	280	40.3	79.4	0.5	0.0	0.0	0.0	0.09
Florida	FL	1996	Winter	12.1	24.6	12.8	0.82	289	50.5	82.7	0.4	0.0	0.0	0.0	0.07
Northeast-NoRFG	NN	1996	Summer	8.6	28.1	12.4	1.03	308	43.2	80.7	1.5	0.0	0.0	0.0	0.27
Northeast-NoRFG	NN	1996	Winter	13.2	23.8	16.2	0.73	222	52.2	83.3	0.8	0.0	0.0	0.0	0.14
Northeast-RFG	NR	1996	Summer	7.9	24.7	11.7	0.65	234	50.5	82.4	10.9	0.0	0.0	0.0	1.94
Northeast-RFG	NR	1996	Winter	12.5	19.7	9.6	0.66	265	59.1	87.0	10.5	0.0	0.0	0.0	1.87
Ohio Valley-NoRFG	ON	1996	Summer	8.7	30.2	10.4	1.24	334	45.3	80.3	0.9	0.0	1.5	0.0	0.68
Ohio Valley-NoRFG	ON	1996	Winter	14.1	25.5	8.8	1.04	310	54.0	82.6	0.4	0.0	1.2	0.0	0.48
Ohio Valley-RFG	OR	1996	Summer	7.8	27.3	8.1	0.99	300	45.5	81.1	9.5	0.0	0.0	0.0	1.69
Ohio Valley-RFG	OR	1996	Winter	12.9	18.9	8.8	0.97	355	59.4	88.4	10.0	0.0	0.0	0.0	1.79
Northern MI/WI	MI	1996	Summer	8.5	28.4	9.1	1.32	277	49.0	80.9	0.5	0.0	2.8	0.0	1.04
Northern MI/WI	MI	1996	Winter	14.0	25.3	8.4	1.46	206	57.6	83.1	0.2	0.0	2.4	0.0	0.85
West Texas	WT	1996	Summer	8.0	30.1	9.7	1.48	263	41.5	81.6	0.2	0.0	0.0	0.0	0.03
West Texas	WT	1996	Winter	11.8	25.8	8.1	1.21	361	47.3	83.7	0.0	0.0	0.0	0.0	0.00

Appendix -- 2007/2020 30 ppm Sulfur Fuel Specifications

Area	Abbrev.	Year	Season	Scenario	RVP, psi	Aromatic	Olefins	Benzene	Sulfur	E200 %	E300 %	MTBE %	ETBE %	EtOH %	TAME %	Oxygen
Atlanta	AT	2007	Summer	30 ppm	7.0	30.9	8.9	0.87	30	38.1	80.2	1.7	0.0	0.0	0.0	0.30
Atlanta	AT	2007	Winter	30 ppm	12.4	24.0	11.4	0.77	30	50.8	82.7	0.6	0.0	0.0	0.0	0.10
Chicago	CH	2007	Summer	30 ppm	6.6	24.1	6.2	0.93	30	51.2	82.7	0.0	13.7	0.0	0.0	2.10
Chicago	CH	2007	Winter	30 ppm	14.0	17.6	2.9	0.80	30	60.1	87.3	0.0	0.0	10.7	0.0	3.70
Denver	DN	2007	Summer	30 ppm	8.8	26.1	7.0	1.33	30	51.3	83.5	0.0	0.0	0.0	0.0	0.00
Denver	DN	2007	Winter	30 ppm	13.6	21.2	8.0	0.94	30	61.7	88.1	0.0	0.0	8.4	0.0	2.90
Houston	HS	2007	Summer	30 ppm	6.7	26.8	9.7	0.78	30	48.5	82.5	11.2	0.0	0.0	0.0	2.00
Houston	HS	2007	Winter	30 ppm	12.8	19.7	5.0	0.67	30	56.5	86.4	10.6	0.0	0.0	0.0	1.90
Minneapolis	MN	2007	Summer	30 ppm	9.6	27.2	5.8	1.81	30	60.6	85.1	0.0	0.0	9.6	0.0	3.30
Minneapolis	MN	2007	Winter	30 ppm	14.9	22.7	4.7	1.65	30	61.9	89.1	0.0	0.0	8.1	0.0	2.80
New York	NY	2007	Summer	30 ppm	6.8	25.8	11.9	0.59	30	49.9	83.8	11.2	0.0	0.0	0.0	2.00
New York	NY	2007	Winter	30 ppm	13.2	19.3	5.8	0.53	30	58.1	88.0	14.6	0.0	0.3	0.0	2.70
Philadelphia	PA	2007	Summer	30 ppm	6.7	25.0	10.3	0.65	30	51.1	84.1	11.8	0.0	0.0	0.0	2.10
Philadelphia	PA	2007	Winter	30 ppm	13.5	21.0	5.2	0.62	30	56.5	87.6	11.2	0.0	0.0	0.0	2.00
Phoenix	PX	2007	Summer	30 ppm	7.0	22.0	4.0	0.80	30	50.0	92.0	0.0	0.0	6.1	0.0	2.10
Phoenix	PX	2007	Winter	30 ppm	10.6	17.7	3.5	0.57	30	56.3	88.6	0.0	0.0	10.2	0.0	3.50
Spokane	SP	2007	Summer	30 ppm	8.7	27.5	6.6	1.32	30	46.2	81.8	0.0	0.0	0.0	0.0	0.00
Spokane	SP	2007	Winter	30 ppm	14.8	17.9	6.0	0.96	30	59.8	87.2	0.0	0.0	10.2	0.0	3.50
St. Louis	SL	2007	Summer	30 ppm	6.4	28.8	11.3	0.72	30	45.0	79.6	0.0	13.7	0.0	0.0	2.10
St. Louis	SL	2007	Winter	30 ppm	13.6	20.7	4.9	0.89	30	52.5	84.7	0.0	0.0	6.1	0.0	2.10
Western Washington/Oregon	WA	2007	Summer	30 ppm	8.0	34.5	5.3	2.17	30	45.2	82.8	0.0	0.0	0.0	0.0	0.00
Western Washington/Oregon	WA	2007	Winter	30 ppm	13.5	27.6	5.3	1.81	30	55.4	84.2	0.0	0.0	2.9	0.0	1.00
Western Washington/Oregon	WB	2007	Summer	30 ppm	8.0	34.5	5.3	2.17	30	45.2	82.8	0.0	0.0	0.0	0.0	0.00
Western Washington/Oregon	WB	2007	Winter	30 ppm	13.5	27.6	5.3	1.81	30	55.4	84.2	0.0	0.0	2.9	0.0	1.00
Northern California	CN	2007	Summer	30 ppm	7.0	22.0	4.0	0.80	30	50.0	92.0	0.0	0.0	6.1	0.0	2.10
Northern California	CN	2007	Winter	30 ppm	10.5	20.1	2.1	0.52	30	54.4	90.8	0.0	0.0	6.1	0.0	2.10
Southern California	CS	2007	Summer	30 ppm	7.0	22.0	4.0	0.80	30	50.0	92.0	0.0	0.0	6.1	0.0	2.10
Southern California	CS	2007	Winter	30 ppm	10.6	17.7	3.5	0.57	30	56.3	88.6	0.0	0.0	6.1	0.0	2.10
Idaho/Montana/Wyoming	ID	2007	Summer	30 ppm	8.5	27.3	6.5	1.64	30	48.0	85.0	1.1	0.0	0.0	0.0	0.20
Idaho/Montana/Wyoming	ID	2007	Winter	30 ppm	13.5	22.1	5.6	1.40	30	53.3	84.6	0.6	0.0	0.0	0.0	0.10
Utah/New Mexico/Nevada	UT	2007	Summer	30 ppm	8.0	29.6	8.5	1.75	30	46.4	84.0	2.2	0.0	0.0	0.0	0.40
Utah/New Mexico/Nevada	UT	2007	Winter	30 ppm	14.4	19.8	7.2	1.14	30	71.7	85.2	0.0	0.0	10.4	0.0	3.60
ND/SD/NE/IA/KS/Western MO	ND	2007	Summer	30 ppm	8.3	28.0	6.4	1.33	30	46.6	82.2	0.0	0.0	3.5	0.0	1.20
ND/SD/NE/IA/KS/Western MO	ND	2007	Winter	30 ppm	13.4	21.7	6.0	1.12	30	55.6	85.0	0.6	0.0	1.7	0.0	0.70
AR/MS/AL/SC/Northern LA	SE	2007	Summer	30 ppm	7.7	29.6	10.5	0.84	30	40.0	78.5	1.1	0.0	0.0	0.0	0.20
AR/MS/AL/SC/Northern LA	SE	2007	Winter	30 ppm	12.2	23.7	11.3	0.81	30	50.1	82.3	0.6	0.0	0.0	0.0	0.10
Florida	FL	2007	Summer	30 ppm	7.6	32.4	8.1	0.79	30	41.5	79.8	1.1	0.0	0.0	0.0	0.20
Florida	FL	2007	Winter	30 ppm	12.1	23.8	11.2	0.82	30	50.1	82.7	0.6	0.0	0.0	0.0	0.10
Northeastern states - non RFG	NN	2007	Summer	30 ppm	8.6	27.1	9.9	1.03	30	44.4	81.1	3.4	0.0	0.0	0.0	0.60
Northeastern states - non RFG	NN	2007	Winter	30 ppm	13.2	23.1	14.1	0.73	30	51.8	83.3	0.6	0.0	0.0	0.0	0.10
Northeastern states- with RFG	NR	2007	Summer	30 ppm	6.7	24.0	11.0	0.67	30	50.8	83.2	11.2	0.0	0.0	0.0	2.00
Northeastern states- with RFG	NR	2007	Winter	30 ppm	12.5	18.2	4.8	0.66	30	59.6	89.7	10.6	0.0	0.0	0.0	1.90
Ohio Valley - non-RFG	ON	2007	Summer	30 ppm	8.7	29.1	8.3	1.24	30	46.5	80.7	1.7	0.0	2.9	0.0	1.30
Ohio Valley - non-RFG	ON	2007	Winter	30 ppm	14.1	24.7	7.7	1.04	30	53.6	82.6	0.6	0.0	1.2	0.0	0.50
Ohio Valley - with RFG	OR	2007	Summer	30 ppm	6.5	27.1	7.6	1.02	30	45.6	81.9	9.5	0.0	0.0	0.0	1.70
Ohio Valley - with RFG	OR	2007	Winter	30 ppm	12.9	17.4	4.4	0.97	30	59.9	91.1	10.1	0.0	0.0	0.0	1.80
Northern MI/WI/MN	MI	2007	Summer	30 ppm	8.5	27.4	7.3	1.32	30	50.2	81.3	1.1	0.0	5.8	0.0	2.20
Northern MI/WI/MN	MI	2007	Winter	30 ppm	14.0	24.5	7.3	1.46	30	57.2	83.1	0.0	0.0	2.3	0.0	0.80
West Texas	WT	2007	Summer	30 ppm	8.0	29.1	7.8	1.48	30	42.7	82.0	0.6	0.0	0.0	0.0	0.10
West Texas	WT	2007	Winter	30 ppm	11.8	24.9	7.1	1.21	30	46.8	83.7	0.0	0.0	0.0	0.0	0.00

Appendix -- 1996 Baseline Fuel Specifications

Area	Abbrev.	Year	Season	RVP, psi	Aromatics	Olefins	Benzene %	Sulfur	E200 %	E300 %	MTBE %	ETBE %	EtOH %	TAME %	Oxygen wt
Atlanta	AT	1996	Summer	7.2	32.1	11.2	0.87	343	36.9	79.8	0.7	0.0	0.0	0.0	0.13
Atlanta	AT	1996	Winter	12.4	24.8	13.0	0.77	447	51.2	82.7	0.3	0.0	0.0	0.0	0.06
Chicago	CH	1996	Summer	7.9	26.0	9.7	0.96	492	50.2	80.8	0.0	0.0	9.0	0.0	3.12
Chicago	CH	1996	Winter	14.0	22.4	7.8	0.80	523	58.0	83.9	0.0	0.0	9.0	0.0	3.11
Denver	DN	1996	Summer	8.8	27.1	8.8	1.33	296	50.1	83.1	0.0	0.0	0.0	0.0	0.00
Denver	DN	1996	Winter	13.6	21.9	9.2	0.94	350	62.1	88.1	0.0	0.0	8.4	0.0	2.91
Houston	HS	1996	Summer	7.1	27.4	13.0	0.71	261	47.8	79.8	9.8	0.0	0.0	0.0	1.74
Houston	HS	1996	Winter	12.8	21.1	12.8	0.70	224	59.9	83.8	7.9	0.0	0.0	0.0	1.41
Minneapolis	MN	1996	Summer	9.6	28.2	7.3	1.81	121	59.4	84.6	0.0	0.0	9.4	0.0	3.24
Minneapolis	MN	1996	Winter	14.9	23.4	5.3	1.65	70	62.3	89.1	0.0	0.0	8.0	0.0	2.77
New York	NY	1996	Summer	8.0	28.6	17.1	0.51	231	49.8	81.5	10.6	0.0	0.0	0.0	1.89
New York	NY	1996	Winter	13.2	23.3	16.6	0.47	267	57.5	85.7	14.5	0.0	0.0	0.0	2.58
Philadelphia	PA	1996	Summer	7.9	29.0	12.3	0.80	367	51.2	81.8	11.3	0.0	0.0	0.0	2.01
Philadelphia	PA	1996	Winter	13.5	25.4	10.2	0.63	337	59.3	85.9	8.8	0.0	0.0	0.0	1.58
Phoenix	PX	1996	Summer	6.8	36.1	6.8	1.07	118	45.7	76.2	0.8	0.0	0.0	0.0	0.14
Phoenix	PX	1996	Winter	8.7	34.3	7.1	1.40	216	50.2	82.6	0.0	0.0	10.2	0.0	3.53
Spokane	SP	1996	Summer	8.7	28.5	8.3	1.32	412	45.0	81.4	0.0	0.0	0.0	0.0	0.00
Spokane	SP	1996	Winter	14.8	18.6	6.9	0.97	350	59.8	87.1	0.0	0.0	9.3	0.0	3.21
St. Louis	SL	1996	Summer	6.8	29.9	12.0	0.70	492	39.0	78.8	0.0	0.0	0.0	0.0	0.00
St. Louis	SL	1996	Winter	13.6	23.8	11.4	0.89	535	52.7	82.6	0.0	0.0	0.0	0.0	0.00
Western WA/OR - Win 95/96	WA	1996	Summer	8.0	35.7	6.7	2.17	256	44.0	82.4	0.1	0.0	0.0	0.0	0.02
Western WA/OR - Win 95/96	WA	1996	Winter	13.6	27.5	6.3	1.81	342	58.8	84.5	0.0	0.0	4.3	0.0	1.49
Western WA/OR - Win 96/97	WB	1996	Summer	8.0	35.7	6.7	2.17	256	44.0	82.4	0.1	0.0	0.0	0.0	0.02
Western WA/OR - Win 96/97	WB	1996	Winter	13.4	29.4	5.8	1.81	345	52.7	84.0	0.0	0.0	1.3	0.0	0.44
Northern California	CN	1996	Summer	6.9	24.4	3.5	0.56	26	49.3	89.9	9.1	0.0	0.0	0.0	1.63
Northern California	CN	1996	Winter	10.5	20.1	2.1	0.52	30	54.4	90.8	10.5	0.0	0.0	0.0	1.87
Southern California	CS	1996	Summer	7.0	20.7	4.3	0.52	10	51.0	86.8	11.0	0.0	0.0	0.0	1.96
Southern California	CS	1996	Winter	10.6	17.7	3.5	0.57	31	56.3	88.6	11.6	0.0	0.0	0.0	2.08
ID/MT/WY	ID	1996	Summer	8.5	28.3	8.1	1.64	318	46.8	84.6	0.5	0.0	0.0	0.0	0.09
ID/MT/WY	ID	1996	Winter	13.5	22.8	6.4	1.40	252	53.7	84.6	0.5	0.0	0.0	0.0	0.09
UT/NM/NV	UT	1996	Summer	8.0	30.7	10.6	1.75	207	45.2	83.6	1.1	0.0	0.0	0.0	0.20
UT/NM/NV	UT	1996	Winter	14.4	20.4	8.3	1.14	106	72.2	85.2	0.0	0.0	10.3	0.0	3.54
ND/SD/NE/IA/KS/Western MO	ND	1996	Summer	8.3	29.0	8.0	1.33	229	45.4	81.8	0.1	0.0	1.7	0.0	0.59
ND/SD/NE/IA/KS/Western MO	ND	1996	Winter	13.4	22.4	6.8	1.12	224	56.0	85.0	0.4	0.0	1.8	0.0	0.68
AR/MS/AL/SC/Northern LA	SE	1996	Summer	7.7	30.7	13.2	0.84	349	38.8	78.1	0.5	0.0	0.0	0.0	0.08
AR/MS/AL/SC/Northern LA	SE	1996	Winter	12.2	24.5	13.0	0.81	271	50.5	82.3	0.4	0.0	0.0	0.0	0.08
Florida	FL	1996	Summer	7.6	33.6	10.1	0.79	280	40.3	79.4	0.5	0.0	0.0	0.0	0.09
Florida	FL	1996	Winter	12.1	24.6	12.8	0.82	289	50.5	82.7	0.4	0.0	0.0	0.0	0.07
Northeast-NoRFG	NN	1996	Summer	8.6	28.1	12.4	1.03	308	43.2	80.7	1.5	0.0	0.0	0.0	0.27
Northeast-NoRFG	NN	1996	Winter	13.2	23.8	16.2	0.73	222	52.2	83.3	0.8	0.0	0.0	0.0	0.14
Northeast-RFG	NR	1996	Summer	7.9	24.7	11.7	0.65	234	50.5	82.4	10.9	0.0	0.0	0.0	1.94
Northeast-RFG	NR	1996	Winter	12.5	19.7	9.6	0.66	265	59.1	87.0	10.5	0.0	0.0	0.0	1.87
Ohio Valley-NoRFG	ON	1996	Summer	8.7	30.2	10.4	1.24	334	45.3	80.3	0.9	0.0	1.5	0.0	0.68
Ohio Valley-NoRFG	ON	1996	Winter	14.1	25.5	8.8	1.04	310	54.0	82.6	0.4	0.0	1.2	0.0	0.48
Ohio Valley-RFG	OR	1996	Summer	7.8	27.3	8.1	0.99	300	45.5	81.1	9.5	0.0	0.0	0.0	1.69
Ohio Valley-RFG	OR	1996	Winter	12.9	18.9	8.8	0.97	355	59.4	88.4	10.0	0.0	0.0	0.0	1.79
Northern MI/WI	MI	1996	Summer	8.5	28.4	9.1	1.32	277	49.0	80.9	0.5	0.0	2.8	0.0	1.04
Northern MI/WI	MI	1996	Winter	14.0	25.3	8.4	1.46	206	57.6	83.1	0.2	0.0	2.4	0.0	0.85
West Texas	WT	1996	Summer	8.0	30.1	9.7	1.48	263	41.5	81.6	0.2	0.0	0.0	0.0	0.03
West Texas	WT	1996	Winter	11.8	25.8	8.1	1.21	361	47.3	83.7	0.0	0.0	0.0	0.0	0.00

Appendix -- 2007/2020 30 ppm Sulfur Fuel Specifications

Area	Abbrev.	Year	Season	Scenario	RVP, psi	Aromatic	Olefins	Benzene	Sulfur	E200 %	E300 %	MTBE %	ETBE %	EtOH %	TAME %	Oxygen
Atlanta	AT	2007	Summer	30 ppm	7.0	30.9	8.9	0.87	30	38.1	80.2	1.7	0.0	0.0	0.0	0.30
Atlanta	AT	2007	Winter	30 ppm	12.4	24.0	11.4	0.77	30	50.8	82.7	0.6	0.0	0.0	0.0	0.10
Chicago	CH	2007	Summer	30 ppm	6.6	24.1	6.2	0.93	30	51.2	82.7	0.0	13.7	0.0	0.0	2.10
Chicago	CH	2007	Winter	30 ppm	14.0	17.6	2.9	0.80	30	60.1	87.3	0.0	0.0	10.7	0.0	3.70
Denver	DN	2007	Summer	30 ppm	8.8	26.1	7.0	1.33	30	51.3	83.5	0.0	0.0	0.0	0.0	0.00
Denver	DN	2007	Winter	30 ppm	13.6	21.2	8.0	0.94	30	61.7	88.1	0.0	0.0	8.4	0.0	2.90
Houston	HS	2007	Summer	30 ppm	6.7	26.8	9.7	0.78	30	48.5	82.5	11.2	0.0	0.0	0.0	2.00
Houston	HS	2007	Winter	30 ppm	12.8	19.7	5.0	0.67	30	56.5	86.4	10.6	0.0	0.0	0.0	1.90
Minneapolis	MN	2007	Summer	30 ppm	9.6	27.2	5.8	1.81	30	60.6	85.1	0.0	0.0	9.6	0.0	3.30
Minneapolis	MN	2007	Winter	30 ppm	14.9	22.7	4.7	1.65	30	61.9	89.1	0.0	0.0	8.1	0.0	2.80
New York	NY	2007	Summer	30 ppm	6.8	25.8	11.9	0.59	30	49.9	83.8	11.2	0.0	0.0	0.0	2.00
New York	NY	2007	Winter	30 ppm	13.2	19.3	5.8	0.53	30	58.1	88.0	14.6	0.0	0.3	0.0	2.70
Philadelphia	PA	2007	Summer	30 ppm	6.7	25.0	10.3	0.65	30	51.1	84.1	11.8	0.0	0.0	0.0	2.10
Philadelphia	PA	2007	Winter	30 ppm	13.5	21.0	5.2	0.62	30	56.5	87.6	11.2	0.0	0.0	0.0	2.00
Phoenix	PX	2007	Summer	30 ppm	7.0	22.0	4.0	0.80	30	50.0	92.0	0.0	0.0	6.1	0.0	2.10
Phoenix	PX	2007	Winter	30 ppm	10.6	17.7	3.5	0.57	30	56.3	88.6	0.0	0.0	10.2	0.0	3.50
Spokane	SP	2007	Summer	30 ppm	8.7	27.5	6.6	1.32	30	46.2	81.8	0.0	0.0	0.0	0.0	0.00
Spokane	SP	2007	Winter	30 ppm	14.8	17.9	6.0	0.96	30	59.8	87.2	0.0	0.0	10.2	0.0	3.50
St. Louis	SL	2007	Summer	30 ppm	6.4	28.8	11.3	0.72	30	45.0	79.6	0.0	13.7	0.0	0.0	2.10
St. Louis	SL	2007	Winter	30 ppm	13.6	20.7	4.9	0.89	30	52.5	84.7	0.0	0.0	6.1	0.0	2.10
Western Washington/Oregon	WA	2007	Summer	30 ppm	8.0	34.5	5.3	2.17	30	45.2	82.8	0.0	0.0	0.0	0.0	0.00
Western Washington/Oregon	WA	2007	Winter	30 ppm	13.5	27.6	5.3	1.81	30	55.4	84.2	0.0	0.0	2.9	0.0	1.00
Western Washington/Oregon	WB	2007	Summer	30 ppm	8.0	34.5	5.3	2.17	30	45.2	82.8	0.0	0.0	0.0	0.0	0.00
Western Washington/Oregon	WB	2007	Winter	30 ppm	13.5	27.6	5.3	1.81	30	55.4	84.2	0.0	0.0	2.9	0.0	1.00
Northern California	CN	2007	Summer	30 ppm	7.0	22.0	4.0	0.80	30	50.0	92.0	0.0	0.0	6.1	0.0	2.10
Northern California	CN	2007	Winter	30 ppm	10.5	20.1	2.1	0.52	30	54.4	90.8	0.0	0.0	6.1	0.0	2.10
Southern California	CS	2007	Summer	30 ppm	7.0	22.0	4.0	0.80	30	50.0	92.0	0.0	0.0	6.1	0.0	2.10
Southern California	CS	2007	Winter	30 ppm	10.6	17.7	3.5	0.57	30	56.3	88.6	0.0	0.0	6.1	0.0	2.10
Idaho/Montana/Wyoming	ID	2007	Summer	30 ppm	8.5	27.3	6.5	1.64	30	48.0	85.0	1.1	0.0	0.0	0.0	0.20
Idaho/Montana/Wyoming	ID	2007	Winter	30 ppm	13.5	22.1	5.6	1.40	30	53.3	84.6	0.6	0.0	0.0	0.0	0.10
Utah/New Mexico/Nevada	UT	2007	Summer	30 ppm	8.0	29.6	8.5	1.75	30	46.4	84.0	2.2	0.0	0.0	0.0	0.40
Utah/New Mexico/Nevada	UT	2007	Winter	30 ppm	14.4	19.8	7.2	1.14	30	71.7	85.2	0.0	0.0	10.4	0.0	3.60
ND/SD/NE/IA/KS/Western MO	ND	2007	Summer	30 ppm	8.3	28.0	6.4	1.33	30	46.6	82.2	0.0	0.0	3.5	0.0	1.20
ND/SD/NE/IA/KS/Western MO	ND	2007	Winter	30 ppm	13.4	21.7	6.0	1.12	30	55.6	85.0	0.6	0.0	1.7	0.0	0.70
AR/MS/AL/SC/Northern LA	SE	2007	Summer	30 ppm	7.7	29.6	10.5	0.84	30	40.0	78.5	1.1	0.0	0.0	0.0	0.20
AR/MS/AL/SC/Northern LA	SE	2007	Winter	30 ppm	12.2	23.7	11.3	0.81	30	50.1	82.3	0.6	0.0	0.0	0.0	0.10
Florida	FL	2007	Summer	30 ppm	7.6	32.4	8.1	0.79	30	41.5	79.8	1.1	0.0	0.0	0.0	0.20
Florida	FL	2007	Winter	30 ppm	12.1	23.8	11.2	0.82	30	50.1	82.7	0.6	0.0	0.0	0.0	0.10
Northeastern states - non RFG	NN	2007	Summer	30 ppm	8.6	27.1	9.9	1.03	30	44.4	81.1	3.4	0.0	0.0	0.0	0.60
Northeastern states - non RFG	NN	2007	Winter	30 ppm	13.2	23.1	14.1	0.73	30	51.8	83.3	0.6	0.0	0.0	0.0	0.10
Northeastern states- with RFG	NR	2007	Summer	30 ppm	6.7	24.0	11.0	0.67	30	50.8	83.2	11.2	0.0	0.0	0.0	2.00
Northeastern states- with RFG	NR	2007	Winter	30 ppm	12.5	18.2	4.8	0.66	30	59.6	89.7	10.6	0.0	0.0	0.0	1.90
Ohio Valley - non-RFG	ON	2007	Summer	30 ppm	8.7	29.1	8.3	1.24	30	46.5	80.7	1.7	0.0	2.9	0.0	1.30
Ohio Valley - non-RFG	ON	2007	Winter	30 ppm	14.1	24.7	7.7	1.04	30	53.6	82.6	0.6	0.0	1.2	0.0	0.50
Ohio Valley - with RFG	OR	2007	Summer	30 ppm	6.5	27.1	7.6	1.02	30	45.6	81.9	9.5	0.0	0.0	0.0	1.70
Ohio Valley - with RFG	OR	2007	Winter	30 ppm	12.9	17.4	4.4	0.97	30	59.9	91.1	10.1	0.0	0.0	0.0	1.80
Northern MI/WI/MN	MI	2007	Summer	30 ppm	8.5	27.4	7.3	1.32	30	50.2	81.3	1.1	0.0	5.8	0.0	2.20
Northern MI/WI/MN	MI	2007	Winter	30 ppm	14.0	24.5	7.3	1.46	30	57.2	83.1	0.0	0.0	2.3	0.0	0.80
West Texas	WT	2007	Summer	30 ppm	8.0	29.1	7.8	1.48	30	42.7	82.0	0.6	0.0	0.0	0.0	0.10
West Texas	WT	2007	Winter	30 ppm	11.8	24.9	7.1	1.21	30	46.8	83.7	0.0	0.0	0.0	0.0	0.00